Flora Desmidiarum Japonicarum

AUTHOR(S):

HIRANO, MINORU

Flora Desmidiarum Japonicarum

Minoru HIRANO

There are some different opinions among the phycologists as to the fundamentals of classification on Desmids and to their positions. W. & G. S. WEST divided the Desmids into two groups, Saccoderm and Placoderm Desmids, while OLTMANNS divided the Conjugatae into three groups, that is, Mesotaeniaceae, Zygnemaceae and Desmidiaceae. According to the latter author's opinion, Saccoderm Desmids mostly belong to Mesotaeniaceae and partly to Zygnemaceae so that both the genera *Gonatozygon* and *Genicularia* belong to Zygnemaceae. Desmidiaceae corresponds to the Placoderm Desmid. On the contrary, F. E. FRITSCH classified the Conjugatae into two groups, Euconjugatae and Desmidioideae. The former is further subdivided into two groups, Mesotaenioideae and Zygnemoideae. The former is Mesotaeniaceae in the sense of OLTMANNS to its extent and content. The latter includes Zygnemaceae, Gonatozygaceae and Mougeotiaceae, the second-named consisting of *Gonatozygon* and *Genicularia*. The latter is Desmidiaceae in OLTMANNS' usage and W. KRIEGER also separated the Conjugatae into two groups, Zygnemales and Desmidiales. The latter is further divided into three families, Mesotaeniaceae, Gonatozygaceae and Desmidiaceae. The present writer deals with the so-called Desmids or Desmidiales according to W. KRIEGER's system.

The present contribution is a result of my researches on Japanese Desmids which had been carried on under the kind guidance of Prof. Gen-ichi KOIDZUMI of Kyoto Imperial University and after his retirement have been continued under the supervision of Prof. Siro KITAMURA of the same university. The writer wishes to express his hearty thanks to the late Prof. G. KOIDZUMI and Prof. S. KITAMURA for their kind guidance and encouragement throughout the work. My own materials upon which the present work is based were collected in various parts of Japan, excluding Sakhalien, the Kuriles, Korea, Liukiu and Formosa.

Some remarks on cell structure

The cell form of Desmids varies in different groups of families. The cells of Gonatozygaceae, Mesotaeniaceae and some genera of Desmidiaceae are elongate and cylindrical in general, not constricted in the middle, so that they are circular in cross section, while in the majority of Desmidiaceae the cells are short in length, distinctly constricted at the median part and compressed, so that the cells are elliptic or oblong in cross section. The cell wall of Gonatozygaceae and Mesotaeniaceae is composed of a single piece so that it is unsegmented, and is smooth on surface and without any pores. In Gonatozygaceae the outer layer of the cell wall is provided with

some markings such as spines or granules, while the cell wall of Desmidiaceae is much differentiated into an inner and outer layer. The inner layer is smooth and structureless but the outer is ornamented with the regular markings of spines and granules. Furthermore the cell wall of this family is characterized by the possession of pores.

The chloroplast locates on the opposite side of the nucleus which lies in the median part of the cell, but in the cases of Saccoderm Desmids such as *Roya*, *Spirotaenia* and *Gonatozygon* or *Genicularia*, the chloroplast extends to both ends of the cell through the whole space of it. The chloroplast of Desmid is principally composed of two types, axile and parietal. In most of Placoderm Desmids and in *Cylindrocystis*, *Netrium* of Saccoderm Desmids, the cell has axile chloroplast. In the small forms of Placoderm Desmids one axile chloroplast is present in each semicell, but two in the large form of cell such as some species of *Cosmarium*, *Euastrum verrucosum* or in the cell of *Xanthidium*. The axile chloroplast is composed of the rod-shaped central piece and of a number of plates or processes around by radiation or projection from the central rod-piece. The pyrenoid is located at the central piece of chloroplast. Therefore in small Desmids it is located at the central part of each semicell, but in large Desmids laterally at the central part. In the elongate form of Desmids such as *Penium* and *Closterium* the pyrenoid is arranged in a row at the central part of the cell. In some species of *Cosmarium* and *Staurastrum* or in species of *Xanthidium* and *Pleurotaenium* the cell has parietal chloroplasts, which appears so many long bands containing a row of pyrenoids in each. The chloroplast band of *Pleurotaenium* is broken up into many small pieces, each of which contains one pyrenoid. The scattered arrangement of pyrenoids in the cell of *Closterium Ehrenbergii* and in the species of *Euastrum* seems to depend on the result by the multiplication of pyrenoid, which, as pointed out by Doctors N. CARTER and DUCELLIER, takes place occasionally even in a case of regular arrangement of them. Such types of chloroplast as seen in Desmids are represented also in other members of Zygnemales. The axile chloroplast is seen in *Zygnema* and the parietal chloroplast is found in both *Mougeotia* and *Spirogyra*. The spirally twisted chloroplast band as seen in *Spirogyra* is represented in *Genicularia* and *Spirotaenia*. The arrangement of pyrenoids is similar from each other to both groups of Desmids and Zygnemales.

The mode of conjugation and germination of zygospore

In reviewing the conjugation of Desmids there are found two main modes, one being the formation of conjugation tube, through which the conjugation takes place, and the other a direct fusion of the amoeboid gametes; the former corresponds to the formation of endozygospore and the latter to the formation of exozygospore as men-

tioned by Yoshik. OKADA.* Another noteworthy question is whether the dissociation of colonial cells takes place prior to the conjugation. In Gonatozygaceae the conjugation takes place between the contact cells of a different filament after the dissociation. The members of the Mesotaeniaceae do not usually form filamentous colony, and even if it forms the colony, it is very short and can easily be separated from each other by slight disturbance. In Mesotaeniaceae the conjugation tube is formed and the sexual fusion takes place in it for the zygospore to be formed in the conjugation tube. This manner somewhat resembles that of conjugation in some species of *Zygnema* or *Debarya* of the Zygnemales, but the filament of these genera is not dissociated. In Desmidiaceae the solitary cells do not generally form the conjugation tube and the zygospore is formed in the gelatinous envelope produced between the two conjugating cells, while in some species the protuberance is formed from the isthmus of each cell and then the conjugation tube is formed by the contact of the protuberances. The sexual fusion takes place in this tube. In filamentous Desmids the dissociation takes place prior to the conjugation, but there are an example that it is not dissociated as in *Desmidium*.

The vegetative cell of Desmid is haploid and the reduction division takes place in prior to the germination of zygospore. As a result of reduction four nuclei are usually formed in this zygospore, but in Gonatozygaceae three of them are degenerated and become functionless, and one nucleus developed into a new individual so that one individual is produced by the germination of zygospore. This type of germination is also found in Zygnemales, while in some genera of Mesotaeniaceae four individuals are produced by the germination, but in some other genera such as *Spirotaenia*, *Mesotaenium* or *Netrium*, two individuals are produced and the remaining two nuclei are degenerated soon after. In Desmidiaceae two new individuals are produced by the germination of zygospore and each individual contains two nuclei, one functional and the other degenerated.

The morphological diversity of zygospore

A few examples of zygospore have been known to Desmids in comparison with a considerable number of species. The writer wishes to try here some considerations based on these limited examples. The primitive forms of zygospore will probably be globose and smooth, while some are of quadrate or irregular forms according to their modes of conjugation. In the manner of conjugation, the quadrate or irregular form of zygospore remains directly their empty mother cells. On the contrary, globose zygospore is free from their empty cell. The former zygospore is produced by the direct contact of their different cells and is confined within their cells to move, while the latter is produced within the gelatinous

* Yoshik. OKADA proposed a new system of classification of Desmids based on the mode of conjugation by the cross check-methode.

envelope produced by their contacting cells in the conjugation. In this type of zygospore formation the conjugation tube is not formed between the two cells. In the conjugation of Zygnemales the amoeboid gamete remains within the coujugation tube and enters into the cells from one filament to other ones through the conjugation tube. In Desmidiaceae the amoeboid gamete moves outward from their mother cells. The most primitive form of zygospore is globose and smooth. This type of zygospore is found in Mesotaeniaceae and Gonatozygaceae, and is also common in some of the Desmidiaceae. Even in *Staurastrum*, a highly evolved form of Desmids, globose and smooth zygospore is reported (*St. dilatatum*), while some species of *Spirotaenia*, a genus of the Mesotaeniaceae have zygospore ornamented by the conical protuberances instead of smooth and globose one. This type of zygospore somewhat resembles that of *Chlamydomonas*. The zygospore ornamented by various kinds of regular markings such as spines or conical protuberances, and verrucae or furcate spines are found in the genera of Desmidiaceae especially in forms which have a well developed constriction at the middle part of the cell. Some of zygospores have specially differentiated into broad elevation at each base of spines or verrucae that are various in length. The protuberances of zygospores as in Mesotaeniaceae are also found in that of Desmidiaceae, so its marking is not peculiar to Mesotaeniaceae. In some species of *Closterium* and *Pleurotaenium* are known the zygospores ornamented by spines or verrucae, but the zygospores of more highly evolved genera which possess a well compressed and deeply constricted cell are elaborate in markings. It is supposed that Desmidiaceae is more highly evolved than Mesotaeniaceae from the view point of zygospore complexity. The zygospore having the most elaborate markings such as furcate spines are formed in the genera, such as *Micrasterias* and *Staurastrum*, which are very elaborate in vegetative cell itself as well as in zygospore.

The relationship between zygospore and vegetative cells

There are some resemblances between the Gonatozygaceae and Mesotaeniaceae. They are as follows: 1. Cells are elongated and circular in cross section. 2. Cell wall consists of one piece and without pore. 3. The outer layer of cell wall is soluble in ammoniac copper oxydate solution. 4. The gamete does not escape from the conjugation tube. 5. Zygospore is globose or quadrate and smooth, and is always attached to the mother cell. While there are some differences between Mesotaeniaceae and Desmidiaceae as to these points. 1. Cells generally short, elliptic or radiate form in cross section and in some species partly circular. 2. Cell wall consists of two pieces, with pores. 3. The outer layer of cell wall is not soluble by ammoniac copper oxydate solution. 4. The conjugating cells does not form the conjugation tube, therefore gamete escaping outwards from the cell. 5. The zygospore is generally ornamented by various markings such as spines, verrucae or papillae. The zygospores which are globose, quadrate or smooth on wall surface are generally found in

Mesotaeniaceae, Gonatozygaceae and some genera of Desmidiaceae which have a simple cell outline with some exceptions. The cells of these families and genera are in general cylindrical, elongated, not constricted in the middle and circular in cross section. In Desmidiaceae the cell wall consists of two pieces but there are two types of cell outline, one being cylindrical and elongated and the other compressed and short. The former type is sometimes slightly constricted and sometimes not constricted in the middle and is always circular in cross section. In some genera such as *Tetmemorus* or *Ichthyocercus* is, however, partly compressed near the apices. The latter type of cell is always distinctly constricted, elaborate and decorate in outline and surface. The zygospore of these genera which possess the elongate and cylindrical cell is globose or quadrate and generally smooth, resembling the zygospore of Mesotaeniaceae or Zygnemales, while in some species such as *Closterium calosporum* the surface of zygospore is somewhat decorated by the verrucae. In *Pleurotaenium ovatum* var. *tumidum* the zygospore is decorated by the mamillate projections. This species is peculiar among the species of *Pleurotaenium* and somewhat resembles the elongate form of *Cosmarium*; its median constriction being prominent and deep. The same manner of zygospore is found in *Cylindrocystis acanthophorum* of Mesotaeniaceae and the mamillate projection is more developed than in *Pl. ovatum* var. *tumidum*. In *Spirotaenia* there has been known the zygospore ornamented by the conical teeth and in addition to this, it is noteworthy that the wall of *Spirotaenia* is not soluble in ammoniac copper oxydate solution. This nature is met with widely in the species of Desmidiaceae. The genus *Spirotaenia* is highly evolved among the Mesotaeniaceae in its spirally twisted parietal chloroplast. The genus *Cosmarium* is highly differentiated making up many variations among the species in the features of the constriction, elongation, cell compression and ornamentation. The type of zygospores in which the wall is smooth and globose is found in species of either compressed or non-compressed cells. The wall of such species of *Cosmarium* is also smooth or ornamented by decoration in various degrees. The decorated zygospores are chiefly ornamented by the mamillate or conical projections, simple or furcate spines and processes. The zygospores which have the conical or mamillate projections are chiefly found in non-compressed species of *Cosmarium*, but other markings such as spines or processes are found only in the compressed forms of the *Cosmarium* and in other genera. The zygospore with the true spines is not found in the cell of *Closterium* and *Pleurotaenium*. In *Cosmarium* the spiny zygospore is confined to the compressed form of cell, which is deeply constricted and the wall of which is smooth or granulated. Some of the spiny zygospores have broad elevation in each base of the spines and the cell wall of these cells which have spiny zygospore is of both smooth and granulated kinds. There is found the spiny zygospore in the genera *Arthrodesmus*, *Euastrum*, *Micrasterias* and *Xanthidium* which are elaborate in the form of cell and in decorations than in that of *Cosmarium*.

In *Cosmarium* the granulated species in general possess zygospore of more elaborate forms than the smooth species. Moreover, there is a tendency that more elaborate zygospore occurs in general in the species which either possess differentiated granules or show some differentiation in ornamentation of granules. The zygospores with furcate spines or forked spines are found in some species of *Cosmarium*, *Micrasterias*, *Euastrum*, *Staurastrum*, *Xanthidium*. In *Cosmarium* it is confined to the granulated cosmaria with the exception of *C. microsphinctum* which is a smooth cosmarium. The cells of *Euastrum* are divided into two types in the matter of their ornamentation of granules on wall surface, one being in disposition differentiated into a marginal and a central group of granules and the other not differentiated in disposition or in the shape of granules themselves. The species with the elaborate furcate and spined zygospore belong to the former type of *Euastrum* and their granule-arrangement is in a radial series with the marginal group, and is in a concentric and rink-like manner with the central one. The species of *Cosmarium* which possess this type of zygospore are different from the other by the marginal shape of the cell. Another type of zygospore which has slender processes occurs among the species of *Micrasterias* and *Staurastrum*. The processes of these species are furcate or doubly furcate at their apices. Two genera *Micrasterias* and *Staurastrum* are highly evolved in marginal sculptures and in compression or radiation of cell, and will probably be placed in the most evolved rank. The genus *Cosmarium* possesses a fairly simple type of zygospores in spite of their many varied forms of cells. Namely it is a noteworthy fact that both species of circular or compressed form of cell in cross section as well as smooth or granulate species which are differentiated in disposition and in the shape of granules are the common type of zygospore of globose and smooth. The zygospore of common and similar type are found in many genera, even in species of various genera which are highly differentiated in shape and form of cell. This fact seems to suggest that the differentiation of zygospore is not always equal as to the progress of evolution against the vegetative cell and is more negative than the cell. So far as the Desmids are concerned, the sexual organ preserves an older type in evolution than the vegetative organ. The genus *Cosmarium* is much highly differentiated in vegetative cell than the genera of Mesotaeniaceae, but the zygospore is fairly simple and remains the globose and smooth form of primitive type that is common in Mesotaeniaceae. The filamentous Desmids seem to be differentiated in Desmid-line. The combination of cell is loose in the primitive type, easily broken up by disturbance or conjugation into their individual cell, but is firm in the higher type attaching processes as developed in *Sphaerozosma* or *Onychonema*. Both genera *Hyalotheca* and *Gymnozyga* of cylindrical cell possess globose and smooth zygospore and have cells slightly constricted, while *Sphaerozosma* and *Onychonema* of compressed cell possess spiny zygospore with their cells deeply constricted. In *Desmidium* the cells consist of compressed, biradiate, and triradiate forms. The

zygospore is generally globose and smooth with the exception of *Desm. Swartzii* which is furnished with markings. In *Hyalotheca* the cell shows a sign of radiation in the possession of three mamillate projections as seen in *H. dissiliens* forma *tridentula*.

Interrelation between some genera of Desmids

Pleurotaenium and *Cosmarium*. Among the species of *Cosmarium*, the elongated and less constricted forms of cell somewhat resemble the cell of *Pleurotaenium*. For instance, *C. turgidum* and *C. subturgidum* are compared with *Pleurotaenium nipponicum* or *Pl. ovatum* var *tumidum* as follows: 1. The cell is very large and elongated in comparison with general forms of *Cosmarium*, but is rather shorter and broader than that of the general forms of *Pleurotaenium*, the whole length and breadth fairly resembling each other. 2. The constriction of *Pl. ovatum* or *Pl. nipponicum* is fairly deep in comparison with the other species of *Pleurotaenium*, while *C. turgidum* or *subturgidum* is less constricted than the general forms of *Cosmarium*. 3. The cell wall is scrobiculated and the chloroplast is parietal. The pyrenoid is numerous and its disposition is the same. Therefore it seems to suggest that both genera, *Cosmarium* and *Pleurotaenium* are closely related each other.

Cosmarium and some genera of *Mesotaeniaceae*. On the other hand, the less constricted small forms of *Cosmarium* such as *C. globosum*, *C. cucurbita* and *C. Palangula* resemble some of the genera of Mesotaeniaceae such as *Cylindrocystis* or *Mesotaenium* in the nature of chloroplast, the outline of cylindrical cell, but differs in the nature of cell wall and in the possession of constriction.

Penium and *Cosmarium*. Some species of *Cosmarium* such as *C. diplosporum* and *Hibernicum*, *oblongum* resemble some forms of *Penium* such as *P. margaritaceum* and *P. rufescens*. These cells of three species of *Cosmarium* mentioned above are much less constricted and seem only a depression. The cell wall is punctuated in *Cosmarium* while in *Penium* it is finely granulated. The chief difference between them is brown colour of cell wall because it contains iron salt.

Cosmarium and *Euastrum*. Some examples suggesting the relation between both genera are *C. Hammeri* var. *protuverans*, *C. Meneghinii*, *C. Clepsydra*, *C. trilobulatum* (zygospore unknown) and *Euastrum insulare*, *E. montanum*, *E. sublobatum* (zygospore unknown). These species of both genera are common in the following respects: 1. The semicells have a median inflation and constriction. 2. The margin of semicell shows a lobe-like manner or semicells are somewhat lobed. 3. The zygospores are globose and furnished with spines. 4. The apex of semicell is retuse or almost flattened. The median inflation or protuberans of semicell is an aspect of *Euastrum*, the nature of which can be observed among the species of *Cosmarium*. In the

smooth and compressed forms of *Cosmarium*, the species that has the median inflation are rich in number. The apical incision at the polar lobe of *Euastrum* is a marked nature of the genus with its incision generally deep and linear, while some species possess a shallow and open incision. Moreover the lobed margin of semicell is the chief nature of *Euastrum*. Therefore, both genera *Cosmarium* and *Euastrum* are in close relation to the above examples. The second examples showing the relation between both genera are *C. Elewdrumense*, *C. Boekii* and *E. bidentatum* var. *scrobiculatum*, *E. elegans* var. *bidentatum*. The resemblances between the species of both genera are the followings: 1. The semicells have a median inflation. 2. The granules on wall surface are distinctly divided into central and peripheral series, their disposition and the shape of granules being distinctly differentiated. 3. The margin of semicell is lobe-like manner. 4. The zygospore is ornamented by spines. But the species of *Euastrum* are different from the *Cosmarium* by the possession of apical incision. The third examples showing the relation of both genera are *C. ornatum*, *C. commissulare*, *C. Corcula* and *E. spinulosum*, *E. subornatum*. The resemblances between both genera are the followings: 1. The semicell are trapeziform or truncate pyramidate. 2. The apex of semicell is produced. 3. The granules are divided into two groups in central and peripheral series, their disposition similar to each other. 4. The semicells have a median inflation. 5. The zygospores are provided with furcate processes. Some of the examples mentioned above are not the typical forms which represent the general nature of the genus, but *Cosmarium* and *Euastrum* comprise the diversity forms because of a high evolution. Therefore, the fact that some species of both genera resemble each other seems to suggest the close relation of both genera. But, judging from their shapes of zygospore and semicell, *Euastrum* will probably be more differentiated than *Cosmarium*.

Micrasterias and *Euastrum*. The zygospores of *Euastrum* and of *Micrasterias* are both globose and ornamented by spines, while in *M. papillifera* the zygospore has double furcate processes and moreover in *M. denticulata* it is somewhat variable in the manner of spine. In an extreme instance, both the simple and double spines are ornamented on the same zygospore. The vegetative cells are fairly different from each other, but the basal inflation of the semicell and the nature of division into lobes are common in both genera. *M. apiculata* and *E. spinulosum* var. *Henriquesii* somewhat resemble each other in some respects. 1. The upper lobe of *E. spinulosum* var. *Henriquesii* is produced into a process in the similar manner. This nature is rare in the species of *Euastrum*, but some species in *Micrasterias* such as *M. Mahabuleshwarensis* and *M. tropica* have process-like lobes. 2. Both the species have series of denticulations, its disposition and nature well resembling each other.

Cosmarium and *Micrasterias*. The vegetative cells are quite different from each other because of a well differentiated form of *Micrasterias* cell, but the zygospores

resemble each other in general. In some species of *Micrasterias* are more differentiated and more elaborate in the process of decoration. No direct connecting species between *Cosmarium* and *Micrasterias* have hitherto been known.

Tetmemorus and *Euastrum*. Both of the genera are resemble each other in some respects: 1. The cells have an apical incision which is narrowly linear. 2. The semicells have a basal inflation. 3. The cell wall is scrobiculated, the disposition of which are similar. But both genera are different in some respects by the fact that: 1. The semicells of *Euastrum* are so well lobed in general that are elaborate, while the lateral margin of *E. ansatum* is not lobed. 2. The cells of *Euastrum* are compressed and short, while in *Tetmemorus* they are almost cylindrical and elongate but partly compressed. The cells of *Euastrum* suggests the relation between both genera to a certain extent. The difference between this species and *Tetmemorus* is either the elongation or broadness of cell.

Cosmarium and *Staurastrum*. Both genera, *Cosmarium* and *Staurastrum* are highly differentiated in different directions. *Cosmarium* is chiefly differentiated towards the compression of cell and ornamentation of markings on the wall surface, while the *Staurastrum* is, on the other hand, differentiated towards the radiation of cell and the formation of process. Some species show a biradiate form in a normal way, i.e., *St. Duacense*, *St. Johnsonii*, *St. leptocladum* while these species have well developed processes at each apical angle. The possession of processes is a nature particular to *Staurastrum* but the biradiate form retains an old type of cell. There are some noteworthy examples between *Staurastrum* and *Cosmarium*. *St. Zahlbruckneri*, *St. orbiculare* and *St. muticum* are all in the cell similar outline to that of *Cosmarium*, although the cells of these species are triradiate. The cells of *Cosmarium* such as *C. amplum* forma *trigona* are, on the other hand, granulate cosmaria and are of triradiate form. Its granules are arranged in horizontal and oblique series as in *C. Quadrum* or *C. pseudobroomei*. Further, *C. costatum* var. *triquetrum* is triradiate, its granules being differentiated into peripheral and central groups. The former granules are radial and the latter ones vertical in series. This arrangement is quite a nature of *Cosmarium* but the cell is triradiate. Therefore, these species of *Cosmarium* and of *Staurastrum* are the intermediate forms between these two genera. The following species are closely related in both genera: *C. commissulare*, *C. ornatum* and *St. teliferum*, *St. granulosum*, *St. denticulatum*. The respects to both groups of species are the followings: 1. The semicells have an inflated median part. 2. The granules are arranged in concentric series around the apical angles. 3. The shape of zygospore resembles each other, but are different in the following respects: That is, 1. cell of *Cosmarium* is biradiate while in *Staurastrum* is triradiate. 2. in *Staurastrum* the cell is covered with spines or denticulations instead of granules. The following two groups of species show some stages of transitions from *Cosmarium*

to *Staurastrum*. *C. phaseolus*, *C. Clepsydra* and *St. grande*, *St. Bieneanum*, *St. orbiculare* var. *Ralfsii*. The respects noteworthy to both groups are the followings: 1. The cell of *Cosmarium* are prominently inflated in the median part of semicell and are about to pass into the triradiate form. 2. The semicells are similar to each other in front view. 3. The zygospores are globose and provided with spines. The genus *Staurastrum* succeed in the majority of species in differentiating towards the radiation and in the formation of processes. However, the states of zygospores remain in the shape of *Cosmarium* because both the zygospores generally well resemble each other. There is another example to show the possibility of transition from cylindrical forms of *Cosmarium* to *Staurastrum*. Both genera should be compared with each other in the following species; *C. amoenum* and its allied species and *St. pileolatum* and *St. capitulum*. Both are of less constricted form and are ornamented by a number of granules, but its arrangement is different. One is characteristic to *Cosmarium* and its series of granules are transverse, vertical, or oblique, while the other is partly concentric around the angles. The cell of *Cosmarium* is circular in vertical view while the cell of *Staurastrum* varies from tri- to polyradiate.

Arthrodesmus and *Xanthidium*. The difference between both genera is slight and the chief differences are inflation of median part of semicell and decoration on the inflation. The typical form of *Xanthidium* is distinctly inflated and is ornamented with the granules, but some species are quite smooth and only incrassated at the middle of the semicell. The cell of *Xanthidium* is provided with spines which are generally disposed at the angles either in pairs or rarely in single, while the cell of *Arthrodesmus* is always single at each angle.

Comarium and *Arthrodesmus*. Some species of *Cosmarium* suggest a close relation to those of *Arthrodesmus*. They are: *C. contractum*, *C. tenue*, *C. depressum*, *C. melanosporum*, and *A. convergens*, *A. subulatus*. The nature common to those species of both genera are the followings: 1. The semicells are both elliptical in outline. 2. The cell is elliptical in vertical view without any inflation. 3. The zygospores are globose and smooth. The only difference between both groups of the genera is the possession of spines in vegetative cell; however, in *A. convergens* the spines are very variable, long, very short or scarcely visible as a papilla at the basal angle. Some instances of *Cosmarium* such as *C. obsoletum* and *smolandicum* show the presence of a papilla at each basal angle.

Cosmarium and *Xanthidium*. The chief differences between the two genera are in respect of the possession of a median inflation or protuberance and of spines. In general all the species of *Xanthidium* possess the median inflation or protuberance at both sides of the semicell, and this nature is also found in some groups of the genus *Cosmarium*. The paired spines are characteristic to the *Xanthidium* but

the smallest ones are also found in some species of *Cosmarium*. For instance, *C. triplicatum* var. *paucius* possesses short spines or conical granules, although the cell is destitude of median protuberance. *X. concinnum* also possesses minute spines and median protuberances. There is, therefore, no essential difference between *Xanthidium* and *Cosmarium*. The genus *Xanthidium* would probably be branched from *Cosmarium*, though it seems to be more differentiated in form than the cell of *Arthrodesmus* as in regard to the nature of zygospore.

Arthrodesmus and *Staurastrum*. Both the genera are closely related in some respects, as are suggested by the following examples: *St. dejectum*, *St. apiculatum*, *St. Dickiei*, *St. mucronatum*, *A. Incus*, and *A. controversus*. The resemblances between them are as follows: 1. The outline of semicell. 2. Cells are provided with a single spine at the angle. 3. The zygospores have spines. The difference between them is in the radiation of cell. The group of *Staurastrum* is differentiated in radiate forms from an elliptic and compressed form in end view, as is *Cosmarium* or *Arthrodesmus*, but it remains in the state of *Arthrodesmus* so far as the zygospore is concerned.

Staurastrum and *Xanthidium*. There is an instance of triradiate form of *Xanthidium*, namely: *X. antilopaeum* var. *triquetrum*. This seems to be a connecting form between both genera.

Euastrum and *Staurastrum*. There is no adequate instance to show the connection between these two genera, but the cells of *E. divergens* var. *bifidum* and of *E. ornatum* suggest the relation of connection to same extent. The ouline of semicell is different from each other. The following points are, however, similar in regard to the nature of *Staurastrum*. 1. The upper lateral angles of these species of *Euastrum* are produced in the process of the same folm. 2. The denticulations in this process show the nature of *Staurastrum* in disposition. 3. The zygospores possess the furcate process which is common with that of *Staurastrum*. It is difficult to find the common characteristics because of a highly differentiation of both genera in different directions.

The *colonial Desmids*. Among the colonial Desmids, the vegetative cells of cylindrical form are found in the genera *Hyalotheca* and *Gymnozyga* and a part of *Cosmocladium*. The zygospores of these genera are generally globose or oval and their cell walls are smooth. In *Cosmocladium* the zygospores have blunt spines. The two genera *Hyalotheca* and *Cosmocladium* would have probably been differentiated from the *Cosmarium*-type of cell because of their compressed and constricted cell. *Gymnozyga* has a special mode of cell division and has striated cell wall, so that it would have been differentiated from the common ancestor with *Penium* and *Closterium*.

The *Spondylosium*, *Onychonema* and *Sphaerozosma* also would have been derived from the cells of *comarium*-type because they possess the compressed cell and deep constriction. But the latter two are suitable for filamentous mode of life because of having attaching processes at each apex. The zygospores are quite equal in these three genera. The genus *Desmidium* is radiate in cell form but its zygospore is globose and smooth.

There is a hypothesis concerning that the origin of Desmids depend on the ancestral members of Volvocales. The sexual fusion of gametes in *Chlamydomonas eugametos* resembles in some manner that in some species of Mesotaeniaceae. The three kinds of chloroplasts, plate-like, axile and parietal, are known in the species of *Chlamydomonas* as well as in Desmids. Some zygospores of *Chlamydomonas* possess stellate or reticulate markings on the wall surface and resembles those of *Spirotaenia*. These facts seem to support this hypothesis. It is, however, difficult to decide whether or not Desmids had been derived evolutionally in the direct line from the ancestral Volvocales because all intermediate forms had been lost. There are many common features to the families of Conjugatae, but there are some differences between Desmidiales and Zygnemales. These two groups would probably have been evolved in separate courses from the common ancestor. I have previously called these two evolutional courses as *Desmid*-line and *Zygnema*-line. In the *Desmid*-line the species had been chiefly differentiated in the cell outline simultaneously with the compression and constriction of cell and also radiation of cell. In the *Zygnema*-line, on the contrary, no differentiation of cell form had taken place but the colonization and elongation of cells had occurred. The conjugation had first taken place out of cells, namely the amoeboid gametes had escaped from their mother cells. In more evolved forms of species, however, the conjugation tube had been produced and gamete fusion had become to take place through this conjugation tube. Therefore, the highest mode of conjugation is the scalariform conjugation of *Spirogyra* and of *Zygnema*. However, there are various intermediate modes of conjugation among the members of Zygnemales. In some species gamete union takes place on one of the conjugating cells through the tube and in some other ones it takes place in the tube; in the species of *Sirogonium* conjugating cells are not formed in the conjugation tube, the cells being directly conjugated and forming the zygospore there. In Desmidiaceae most of the species are not formed in the conjugation tube, both cells producing the gelatinous mass between them, and gamete union takes place in this envelope.

In some species the primitive conjugation tube is found between both conjugating cells. The conjugation in the gelatinous envelope seems to confine the movement of gametes in it. I have already mentioned how many number of individuals would be produced in the germination of zygospore. In primitive group one zygospore would produce four individuals in their germination, i. e., in consequence of

reduction division there are produced four nuclei, each of which becomes a new individual respectively. This resembles individual formations in the germination of zygospore of *Chlamydomonas*. The tendency towards the degeneration of nucleus becomes more strong with the evolution progresses. At last three of them degenerate and become functionless, only one individual being produced at the highest stage of evolution. In Desmidiaceae two individuals are generally produced in the germination of zygospore. It has not yet been known whether one individual is produced in the germination of zygospore because of three degenerated nuclei. The species of the Desmidiaceae in general form rather rarely the zygospore and rather few instances have hitherto been known on this matter. It will, therefore, be possible to find in the future the case in which one new individual is produced in the germination of zygospore. In Mesotaeniaceae two cases are known that individuals are produced two in one case and four in another. It seems to me that the mode of germination in the cases of this family shows that in the progress of evolution and that in the cases of Desmidiáceae it is in a more advanced stage. On the other hand, Zygnemaceae usually produced only one individual in the germination of zygospore. The differentiation in cell-form has especially taken place in Desmidiaceae. The direction of evolutional course is two, one being the compression and constriction of cell and radiation and the other elongation and colonization of cell. The firmness in the combination of cells is highly developed in Zygnemaceae, while in the case of Gonatozygaceae it is loose and separated into each cell when conjugation takes place. In the cell of Desmidiaceae, the course of compression and constriction progressed more strongly than that of elongation, and the radiation of cell was derived in the course of diversity. As mentioned above, some disagreement is met with in the degrees of differentiation among the variations of cell form, the mode of conjugation, germination, colony formation, the nature and form of zygospores. These may show non-parallelism or retardation of starting in the course of differentiation.

Mesotaeniaceae

in Oltmanns Morph. Biol. Alg. 1, 83, 1922; West & Fritsch Brit. Alg. 227, 1927; Smith Freshw. Alg. 302, 1950. (pro parte)——*Saccodermeae* in West Monogr. Brit. Desm. 1, 29, 1904. (pro parte)

Cellulae generaliter solitariae, raro in coloniis, coloniis in filamentos breves laxe connectos compositis vel in massa palmelloida in gelatina matricale tectis; cellulae virgam formantes, oblongae vel cylindricae, communiter non constrictae in medio, raro cum leve depressione mediana; membrana non segmentata, glabra, sine poribus; loca divisionum cellularum non difinita certa, divisio septa transversa formantes et non formantes semicellulas ut in desmidi placodermi.

Systema Mesotaeniacearum

1a. Cellulae non longae, circiter 2–3 longiores quam latae.

2a. Chromatophori singuli in unaquaque semicellula.
3a. Chromatophori spiraliter torti, axialia vel parietalia ..... **Spirotaenia**
3b. Chromatophori bractea-formi, axialia..... **Mesotaenium**
2b. Chromatophori bini in unaquaque semicellula.
3a. Chromatophori stellato-formi et radialia, cum pyrenoidibus centralibus magnis. ..... **Cylindrocystis**
3b. Chromatophori cum laminibus longis et radialiter ornatis, apicibus latere laminarum valide incisis ..... **Netrium**
1b. Cellulae elongatae, longiores quam latae. ..... **Roya**

Spirotaenia BRÉB.

in RALFS' Brit. Desm. 178, 1848; LÜTKEMÜLLER Österr. Bot. Ztschr. 92, 1895; WEST Monogr. Brit. Desm. **1**, 37, 1904; SMITH Wisc. Bull. **57**, 5, 1924; WEST & FRITSCH Brit. Alg. 227, 1927; KRIEGER Krypt. Fl. XIII. Abt. **1**. 175, 1933; SMITH Freshw. Alg. U. S. 309, 1950.

Cellulae cylindricae, ellipticae vel fusiformes, non constrictae, lateribus in medio parallelis gradatim attenuatis versus polos, polis generaliter late rotundis vel acute rotundis; membrana glabra sine poris; chromatophoris fasciiformibus, parietalibus vel axialibus, cristatis spiraliter tortis a polo ad polum cum pyrenoidibus pluribus; cellulae saepe in gelatina matricale involtae.

1a. Chromatophoris parietalibus, fasciiformibus ..... **Sp. condensata**
1b. Chromatophoris axialibus cum lamina multo spiraliter ordinatis ..... **Sp. obscura**

Spirotaenia condensata BRÉB. in RALFS Brit. Desm. 149, 1848; ROY & BISSET Journ. Bot. **24**, 242, 1886; WEST Monogr. Brit. Desm. **1**, 38, 1904; KRIEGER Krypt. Fl. XIII. **1**, 181, 1933; OKADA Imp. Fish. Inst. **30**, 138, 1934; **33**, 110, 1939.

Cellulae magnae, cylindricae, circiter 5–12 longiores quam latae, non attenuatae, polis rotundatis; chromatophoris late parietalibus anfractibus (7–12), a polo ad polum extensis. Long. 70–76μ, Lat. 16–17μ.

Hab. **Hokkaido**: Kiritappu in Kushiro. **Hondo**: Mt. Hakkoda in Mutsu; Ooyachi and Hachiman-numa, Mt.Kurikoma, Hizume in Rikuchû; Mt. Komagatake, Ogata in Ugo; Mt. Gassan, Ôishita, Hakuryu-ko, Sugigamine of Mt. Zawo in Uzen; Keshonuma in Rikuzen; Numano-taira of Mt. Bandai, Mt. Azuma, Akaiyachi in Iwashiro; Ozegahara in Kôzuke; Kôyano-ike of Mt. Myoko in Echigo; Shijuhachi-ike of Shigakogen, Mt. Kirigamine, Tengunohara, Happo-ridge, Kazafuki-kaminota in Shinano; Hichimen-zan in Kai; Kurobegoro-daira, Gakino-tanbo in Etchu; Kotsutsumi-nishi-ike in Mikawa; Mt. Hira, Oku-ike of Higashi-kusano-mura in Oomi; Ishigaki-ike, Kanashozu in Ise. **Shikoku**: Yamada in Tosa. (Pl. II. fig. 4)

Distr. Kuriles, Europe, Nova Zembla (Novaya Zemlia), N. & S. America, New Zealand, S. Africa.

Spirotaenia obscura RALFS in Brit. Desm. 179, 1848; WEST Monogr. Brit. Desm. **1**, 44, 1904; HIGASHI List Jap. Freshw. Alg. 268, 1916; KRIEGER Krypt. Fl. XIII, **1**, 180, 1933; HIRANO Act. Phytotax. Geobot. **11**, 275, 1942. ——*Spirotaenia bispiralis* WEST in Journ. Linn. Soc. Bot. **29**, 133, 1892; WEST Monogr. Brit. Desm. **1**, 45, 1904.

Cellulae mediocres, circiter 3–8 longiores quam latiores, cylindricae vel fusiformes, ad polos attenuatae, polis rotundis; chromatophoris axialibus cristatis cum laminis 3–8 spiraliter anfractis in reliquo; cellulae interdum cum gelatinosa vagina. Long. 126μ, Lat. 25μ.

Hab. **Hokkaido:** Kiritappu in Kushiro; Nikuru-numa in Kitami. **Hondo:** Ôuchi-numa in Iwashiro; Ozegahara in Kôzuke; Shinagawa in Musashi (HIGASHI), Ina (FUJISAWA) in Shinano; Kotsutsumi-nishi-ike in Mikawa. **Shikoku:** Yodo-mura in Iyo. (Pl. II fig. 3)

Distr. Japan, Europe, Spitzbergen, Nova Zembla, U. S. A., Australia.

Mesotaenium NÄG.

in Gatt. einz. Alg. 108, 1849; De BARY Conj. 20, 30, 74, 1858; WEST Monogr. Brit Desm. **1**, 48, 1904; WEST & FRITSCH Brit. Alg. 229, 1927; KRIEGER Krypt. Fl. XIII. **1**, 190, 1933; SMITH Freshw. Alg. U. S. 305, 1950.

Cellulae cylindricae vel subcylindricae, rectae vel leviter curvatae, apice generaliter late rotundo, saepe cellulis multis in massa gelatina matricale involtae; chromatophoris singulis raro binis, bractea axiale recta a polo ad polum cellulae extensa, cum pyrenoidibus singulis vel nonnullis; zygosporae polyhedrales.

1a. Cellulae longae et magnae, circiter 4–9 plo longiores quam latiores ..... **M. De Greyi**
2a. Cellulae rectae, non retusae in medio.
3a. Cellulae magnae, 4–4.5 plo longiores quam latiores ..... **f. typica**
3b. Cellulae parvae et breves, 2–3 plo longiores quam latiores ..... var. **breves**
2b. Cellulae retusae in medio ..... var. **Borgei**
1b. Cellulae breves et parvae, circiter 2–3 plo longiores quam latiores.
2a. Apice truncato, chromatophoris centralibus ..... **M. macrococcum**
2b. Apice late rotundo, chromatophoris non centralibus. ..... **M. chlamydosporum**
3a. Cellulae cylindricae, incolorae ..... f. **typica**
3b. Cellulae ellipticae, violaceae ..... var. **violascens**

Mesotaenium De Greyi TURN. in WEST Monogr. Brit. Desm. **1**, 39, 1904; KRIEGER Krypt. Fl. XIII. **1**, 191, 1933; FUJISAWA Journ. Jap. Bot. **10**, 445, 1934.

Cellulae magnae, cylindricae, circiter 3.5 longiores quam latae, lateribus rectis vel leviter curvatis, apicibus rotundis. Long. 77–90μ, Lat. 17–25μ.

Hab. **Hokkaido:** Moor near Lake Tôro in Kushiro. **Hondo:** Mt. Azuma in Iwashiro; Mt. Sanpogamine, Yashimaga-ike of Mt. Kirigamine in Shinano (Fujisawa). **Kiushiu:** Bôgatsuru of Mt. Kujû in Bungo. (Pl. II. fig. 10)

Distr. Japan British Isles, Spain, Germany, New Foundland, Australia.

var. **breves** W. WEST in WEST Monogr. Brit. Desm. **1**, 50, 1904; KRIEGER Krypt. Fl. XIII. **1**, 192, 1933.

Cellulae rectae vel leviter curvatae, circiter 2.5–3.5 longiores quam latae. Long. 60μ, Lat. 16.8μ.

Hab. **Hondo**: Takashihara in Mikawa. (New to Asia) (Pl. II. fig. 12)
Distr. British Isles.

var. **Borgei** (BORGE) KRIEGER in Krypt. Fl. XIII. 1, 193, 1933. —— *Mesotaenium De greyi* TURN. forma BORGE in Ark. Bot. 6, 12, 1906.

Cellulae leviter attenuatae in medio cellulae. Long. 82μ, Lat. 23.7μ.

Hab. **Hondo**: Suiren-numa of Mt. Hakkoda in Mutsu; Mt. Azuma in Iwashiro; Shirouma-ôike in Shinano. (New to Asia) (Pl. II. fig. 11)
Distr. Sweden.

Mesotaenium macrococcum (KÜTZ.) ROY & BISS. in WEST Monogr. Brit. Desm. 1, 51, 1904; KRIEGER Arch. Hydrobiol. Suppl. 11, 157, 1932; Krypt. Fl. XIII. 1, 198, 1933.

Cellulae cylindricae, circiter 2 ⅓ longiores quam latae, apice truncato-rotundato; chromatophoris centralibus interdum marginibus chromatophorum dentibus. Long. 30μ, Lat. 13.4μ.

Hab. **Hondo**: Shimizu-daira of Mt. Nasu in Shimotsuke; Shirouma-kaminota in Shinano. (New to Japan) (Pl. II. fig. 14)
Distr. India, Sumatra, Europe, U. S. A.

Mesotaenium chlamydosporum De BARY in Conj. 75, 1858; WEST Monogr. Brit. Desm. 1, 52, 1904; KRIEGER Krypt. Fl. XIII, 1, 200, 1933.

Cellulae parvae, cylindricae, circiter 3 longiores quam latae, leviter attenuatae ad apices, apice truncato-rotundo; chromatophoris cum pyrenoidibus binis. Long. 36μ, Lat. 11μ.

Hab. **Hondo**: Ômine-numa in Kôzuke. (New to Japan) (Pl. IV. fig, 28)
Distr. Borneo, Europe, N & S. America, West Indies.

var. **violascens** (De BARY) KRIEGER in Krypt. Fl. XIII. 1, 201, 1933.——*Mesotaenium violascens* De BARY in Conj. 32, 1858; WEST Monogr. Brit. Desm. 1, 55, 1904; MIGULA Krypt. Fl. II, 353, 1907.

Cellulae breviores, interdum ellipticae, circiter 1.5–1 ⅔ longiores quam latae, saepe cum gelatina matricali et gelatinis fibrillariformibus. Long. 32–34μ, Lat. 20–22μ.

Hab. **Hondo**: Mt. Azuma in Iwashiro. (New to Asia) (Pl. II. fig. 16)
Distr. Europe, U. S. A., New Zealand, N. Africa.

Cylindrocystis MENEGH.

in De BARY Conj. 30, 35, 74, 1858; WEST Monogr. Brit. Desm. 1, 57, 1904; WEST & FRITSCH Brit. Alg. 229, 1927; KRIEGER Krypt. Fl. XIII, 1, 206, 1933; SMITH Freshw. Alg. U. S. 307, 1950.

Cellulae cylindricae vel ellipticae, non constrictae, vel leviter constrictae in medio, circiter duplo longiores quam latiores, polis generaliter rotundis; membrana glabra; zygosporae quadrangulares vel sphaericae.

1a. Cellulae cylindricae.....**C. Brébissonii**

2a. Cellulae magnae, 30–70×14–22μ
3a. Zygosporae quadratae, cellulae 30–70×14–22μ ..... f. **typica**
3b. Zygosporae globosae, cellulae 20–70×11–23μ ..... var. **Jenneri**
2b. Cellulae parvae, 20–30×8–13μ ..... var. **minor**
1b. Cellulae ellipticae ..... **C. crassa**

Cylindrocystis Brébissonii MENEGH. in WEST Monogr. Brit. Desm. 1, 58, 1904; MIGULA Krypt. Fl. II, 354, 1907; KRIEGER Arch. Hydrobiol. Suppl. 11, 157, 1932; Krypt. Fl. XIII. 1, 207, 1933.

Cellulae parvae, cylindricae, non constrictae, circiter 3 longiores quam latae, apicibus late rotundis; chromatophoris cum brevibus prolongationibus radiantibus paucibus. Long. 36–84μ, Lat. 15.4–17μ.

Hab. **Hondo**: Hizume, Yatsumanako of Mt. Iwate, Mt. Komagatake in Rikuchû; Hirumo-numa in Ugo; Mt. Gassan, Junsai-tsutsumi of Ôishita, Chûkawa-ike in Uzen; Akaiyachi in Iwashiro; Mt. Akagi in Kôzuke; Mt. Eboshi, Gono-ike of Mt. Norikura, Kurobegoro-daira in Etchû; Koshiki-ike, Shirouma-ôike in Shinano; Takashihara in Mikawa; Mizoroga-ike, Ko-ike in Yamashiro. **Kiushiu**: Bôgatsuru of Mt. Kujû in Bungo; Byakushi-ike, Koshiki-ike of Mt. Kirishima in Hiuga. (Pl. I. fig. 10)

Distr. Japan, Korea, India, Burma, Thailand, Java, Europe, Faroes, Iceland, Spitzbergen, Nova Zembla, Greenland, N. & S. America, Azores, E. Africa, Australia, New Zealand.

var. **Jenneri** (RALFS) HANSG. in Arch. naturw. Landes. Böhm. 6, 175, 1888; KRIEGER Krypt. Fl. XIII, 1, 210, 1933; HIRANO Act. Phytotax. Geobot. 11, 275, 1942. —— *Penium Jenneri* RALFS in Brit. Desm. 153, 1848; WEST Monogr. Brit. Desm. 1, 77, 1904; MIGULA Krypt. Fl. II, 366, 1907.

Cellulae cylindricae, non constrictae, circiter duplo longiores quam latiores, apice rotundato. Long. 50μ, Lat. 23μ.

Hab. **Hondo**: Akamizuzawa of Mt. Hakkoda in Mutsu; Ôyachi of Mt. Hachimantai in Rikuchû; Jiuemon-ike, Ayame-daira of Oze in Kôzuke; Naga-ike of Shigakogen in Shinano; Yakumogahara of Mt. Hira in Oomi. (Pl. I. fig. 13)

Distr. Japan, Manchuria, Europe, Central Asia, U. S. A.

var. **minor** W. & G. S. WEST. in Monogr. Brit. Desw. 1, 59, 1904; KRIEGER Krypt. Fl. XIII. 1, 209, 1933; TAFT Ohio Journ. Sci. 45, 185, 1945.

Cellulae minores. Long. 25.8μ, Lat. 9.8–13μ.

Hab. **Hondo**: Mt. Kurikoma, Ôyachi of Mt. Hachimantai in Rikuchû; Koke-numa in Ugo; Numano-taira of Mt. Bandai in Iwashiro; Mt. Kirigamine, Mt. Norikura, Myojin-ike of Kamikochi, Ôhanami-ike in Shinano. **Kiushiu**: Kôga-muta of Aso in Higo. (New to Japan) (Pl. I. fig. 12)

Distr. Korea, Europe.

Cylindrosystis crassa De BARY in Conj. 37, 74, 1858; WEST Monogr. Brit. Desm. 1,

59, 1904; KRIEGER Krypt. Fl. XIII, 1, 211, 1933; OKADA Imp. Fish. Inst. 33, 110, 1939; HIRANO Act. Phytotax. Geobot. 11, 286, 1942.

Cellulae oblongo-cylindricae vel ellipticae, non constrictae, 1.5–2 longiores quam latae, apice late rotundato; chromatophoris steriformibus cum pyrenoidibus centralibus singulis. Long. 30–53μ, Lat. 21–24μ.

Hab. **Hondo**: Kenashitai of Mt. Hakkoda in Mutsu; Ôyachi of Mt. Hachimantai in Rikuchû; Mt. Kurikoma, Koke-numa in Ugo; Mt. Azuma, Numano-taira of Mt. Bandai in Iwashiro; Oze in Kôzuke; Usagishima of Nikko in Shimotsuke; Kurozawano-ike of Mt. Myoko in Echigo; Nt. Kazafuki-ôike, Tengunohara, Shirouma-ôike, Mt. Sanpoga-mine, Ashinota-ike, Inago of Kitamaki-mura, Mt. Kirigamine in Shinano; Mt. Kaminotake, Sennin-ike in Etchû; Shakuhachi-ike in Yamashiro. (Pl. I. fig. 11, 14)

Distr. Japan, the Kuriles, S. China, Borneo, Europe, Spitzbergen, U. S. A., W. Africa, Madagascar, New Zealand.

Netrium (NÄG.) ITZIG. & ROTHE

in WEST Monogr. Brit. Desm. 1, 63, 1904; SMITH Wisc. Bull. 57, 6, 1924; WEST & FRITSCH Brit. Alg. 230, 1927; KRIEGER Krypt. Fl. XIII, 1, 214, 1933; Smith Freshw. Alg. U. S. 308, 1950.

Cellulae generaliter magnae, cylindricae, subcylindricae vel fusiformes, non constrictae, attenuatae ad apices, apice rotundo; membrana glabra sine poris; chromatophoris axialibus generaliter singulis interdum duobus in unaquaque semicellula, cum bracteis 6–12 longitudinalibus et radialibus ad marginem lateris apicis valide incisis; zygosporae sphaericae glabrae.

1a. Cellulae cum chromatophoris duobus ornatae, chromatophoris cum laminibus longis, apicibus latere laminarum valide incisis.
2a. Cellulae fusiformes ..... **N. digitus**
3a. Cellulae magnae, 40–80μ in latitudinem.
4a. Cellulae in margine lateris convexae.
5a. Cellulae in parte apicum leviter elongatae, apice truncato ..... var. **rectum**
5b. Cellulae in parte apicum breves, apice late rotundo ..... f. **typica**
4b. Cellulae in margine lateris rectae in medio ..... var. **lamellosum**
3b. Cellulae parvae, 20–45μ in latitudinem ..... var. **Nägelii**
2b. Cellulae cylindricae ..... **N. oblongum**
3a. Cellulae magnae, 27–39μ in latitudinem ..... f. **typica**
3b. Cellulae parvae, 18–25μ in latitudinem ..... var. **cylindricum**
1b. Cellulae cum chromatophoris quaternis ornatae, chromatophoris cum laminibus longis, apicibus latere laminarum glabris ..... **N. interruptum**
2a. Cellulae magnae, 37–63μ in latitudinem ..... f. **typica**
2b. Cellulae parvae, 15–23μ in latitudinem ..... var. **minor**

Netrium digitus (EHRENB.) ITZIG. & ROTHE in WEST Monogr Brit. Desm. 1, 64, 1904; HIGASHI List Jap. Freshw. Alg. 268, 1916; KRIEGER Krypt. Fl. XIII, 1. 214, 1933; OKADA Imp. Fish. Inst. 30, 139, 1934; HIRANO Act. Phytotax. Geobot. 11. 277, 1942.

Cellulae magnae, fusiformes, non constrictae, circiter 3–4 longiores quam latae, gradatim attenuatae versus apices, apice late rotundo; chromatophoris axialibus cum

longis ramis circa 6 radiantibus, marginibus raminarum incisuris profundis; membrana glabra. Long. 217–290μ, Lat. 72–84μ.

Hab. **Hokkaido:** Junsai-akanuma in Oshima; Akan-junsai-numa, moor of Tôro-numa, Tokotan, Kiritappu in Kushiro; Okineppe in Nemuro; Nikuru-numa in Kitami; Toyokoro in Tokachi; Horomui, Nakano of Sapporo in Ishikari. **Hondo:** Mt. Hakkoda, Mt. Hachimantai, Kurobô-numa in Mutsu; Mt. Iwate, Mt. Kurikoma in Rikuchû; Koke-numa, Hirumo-numa, Moritake-ôtsutsumi, Megata, Mt. Komagatake in Ugo; Eboshi-numa, Mt. Azuma, Mt. Gassan, Hakuryu-ko, Naga-numa of Mazawa, Hijiori-naga-numa, Mt. Zawo in Uzen; Izu-numa, Kesho-numa in Rikuzen; Nogiwano-kwannon-ike, Akai-yachi, Kôriyama in Iwashiro; Nanko, Hibushi-numa in Iwaki; Mt. Akagi, Ozegahara, Ômine-numa in Kôzuke; Usagishima of Nikkô, Shimizu-daira of Mt. Nasu in Shimotsuke; Gôno-ike in Hitachi; Mt. Myoko, Mt. Naeba in Echigo; Shigakogen, Daimon-pass, Midoriga-ike of Mt. Yatsugatake, Mt. Kirigamine, Nenbutsu-ike of Togakushi, Shiroumano-tengunohara, Mt. Kazafuki, Happo-ridge, Kamikochi, Mt. Sanpoga-mine, Kizaki, Nakatsuna, Ashinota-ike in Shinano; Mt. Kumono-taira, Kuro-begoro-daira, Tarobei-daira, Mt. Tateyama in Etchû; Tanuki-numa in Suruga; Ô-numa in Mikawa; Mt. Hira, Shinohara-ike, Fuse-ike in Oomi; Ishigaki-ike, Kanashôzu in Ise; Mizoroga-ike, Ariga-ike in Yamashiro; Ikejiri-ike in Tanba. **Shikoku:** Morimatsu, Matsuyama, Shiramizu-pass in Iyo; Yamada in Tosa; Yamauchi-mura in Sanuki. **Kiushiu:** Yabakei in Bunzen; Bôgazuru of Mt. Kujû in Bungo; Imuta-ike in Satsuma; Byakushi-ike of Mt. Kirishima in Hiuga; Ahira in Ôsumi. (Pl. I. fig. 7)

Distr. Japan, the Kuriles, China, Siberia, Thailand, Malay, Java, Sumatra, India, Ceylon, Europe, N. & S. America, Australia, New Zealand, Azores.

var. **rectum** (TURN.) KRIEGER in Krypt. Fl. XIII, 1, 216, 1933. —— *Penium digitus* (EHRENB.) BRÉB. forma *rectum* TURNER in K. Sv. Vet. Akad. Handl. **25**, 18, 1893.

Cellulae raro angustiores, fusiformes, gradatim attenuatae ad apices, apice truncate rotundo et angusto. Long. 300μ, Lat. 48μ.

Hab. **Hokkaido:** Akan-junsai-numa in Kushiro. **Kiushiu:** Lake Unagi, near Lake Ikeda, Kagami-ike in Satsuma. (New to Japan) (Pl. I. fig. 9)

Distr. Austria, India.

var. **lamellosum** (BRÉB.) GRÖNBL. in Act. Soc. Faun. Flor. Fenn. **47**, 13, 1920; HOMFELD Pflanzenf. **12**, 14, 1929; KRIEGER Krypt. Fl. XIII, **1**, 219, 1933; HIRANO Act. Phytotax. Geobot. **11**, 278, 1942.

Cellulae angustiores, elongato-fusiformes, circiter 5–8 longiores quam latiores, lateribus rectis vel leviter retusis in medio. Long. 272–416μ, Lat. 42–59μ.

Hab. **Hokkaido:** Akan-Junsai-numa in Kushiro; Nikuru-numa in Kitami. **Hondo:** Hakuryu-ko, Kaigui-ike in Uzen; Kesho-numa in Rikuzen; Oze-numa in Kôzuke; Myojin-ike of Kamikochi, Amaga-ike of Mt. Yatsugatake in Shinano; Kotsutsumi-nishi-ike in Mikawa; Jôdo-ike in Ise; Nukigawa of Lake Biwa in Oomi; Ariga-ike in

Yamashiro. **Kiushiu:** Unagi-ike, Nakahama of Lake Ikeda in Satsuma. (Pl. I. fig. 8)

Distr. Japan, China, Java, Malay, Europe, Greenland, N. & S. America, Australia, New Zealand, Hawaii, Azores.

var. **Nägelii** (BRÉB.) KRIEGER in Krypt. Fl. XIII. 1, 218, 1933; HIRANO Act. Phytotax. Geobot. 11, 278, 1942. ——*Netrium Nagelii* (BRÉB.) W. & G. S. WEST in Monogr. Brit. Desm. 1, 66, 1904; OKADA Imp. Fish. Inst. 30, 139, 1934.

Cellulae angustiores et minores; oblongo-lanceolatae, circiter 4–5 longiores. Long. 124–190μ, Lat. 28–56μ.

Hab. **Hokkaido:** Junsai-numa in Oshima; Akan-junsai-numa, moor near Lake Tôro in Kushiro; Okineppe, Onne-numa in Nemuro; Sbiraoi-poruto-numa in Iburi. **Hondo:** Mt. Hakkoda, Mt. Hachimantai, Kurobô-numa, Benje-numa in Mutsu; Koke-numa, Hirumo-numa, Megata, Mt. Komagatake, Mt. Kurikoma in Ugo; Mt. Azuma, Hakuryu-ko, Mt. Gassan, Hijiori-naga-numa, Ôishita, chûkawa-ike, Naga-numa of Mazawa in Uzen; Kôriyama, Nogiwano-kwannon-ike, Akaiyachi in Iwashiro; Kanatsuka-mura, Mt. Myoko, Mt. Naeba, Kôridono-ike in Echigo; Ozegahara, Ômine-numa in Kôzuke; Shigakogen, Daimon-pass, Mt. Kirigamine, Mt. Kazafuki, Shirouma-ôike, Tengunohara, Hoppo-ridge in Shinano; Mt. Eboshi, Mt. Tateyama, Gakinotanbo in Etchû; Kotsutsumi-nishi-ike, Suhara-ike, Takashihara in Mikawa; Tanuki-numa in Suruga; Mt. Hira, Fuse-ike in Oomi; Kanashôzu, Ishigaki-ike, Jôdo-ike in Ise; Mizoroga-ike, Takaraga-ike in Yamashiro. **Kiushiu:** Yabakei in Bunzen; Imuta-ike in Satsuma; Mt. Ôhatayama of Kirishima in Hiuga. (Pl. I. fi. 15)

Distr. Japan, Siberia, Europe, the Kuriles, U. S. A., Brazil, Australia, New Zealand E. Africa.

Netrium oblongum (De BARY) LÜTKEM. in WEST Monogr. Brit. Desm. 1, 66, 1904; KRIEGER Krypt. Fl. XIII, 1, 220, 1933; OKADA Imp. Fish. Inst. 30, 140, 1934; HIRANO Act. Phytotax. Geobot. 11, 279, 1942.

Cellulae mediocres, oblongo-cylindricae, 3–5 longiores quam latae, marginibus lateralibus pene rectis in medio, apice bene rotundo; chromatophoris axialibus cum laminis 6 longis radiantibus, marginibus laminarum profunde incisis ad marginem cellulae; membrana glabra. Long. 115–126μ, Lat. 28–30μ.

Hab. **Hokkaido:** Moor near Lake Tôro in Kushiro. **Hondo:** Mt. Hakkoda, Mt. Hachimantai in Mutsu; Koke-numa, Megata in Ugo; Mt. Kurikoma in Rikuchû; Mt. Azuma in Uzen; Nanko in Iwaki; Ozegahara in Kôzuke; Usagishima in Shimotsuke; Kôridono-ike in Echigo; Shibu-ike of Shigakogen, Mt. Kazafuki, Tengunohara, Happo-ridge, Mt. Kirigamine in Shinano; Kumono-taira in Etchû. (Pl. I. fig. 17)

Distr. Japan, the Kuriles, China, India, Europe, Faroes, N. & S. America, Somaliland, Africa.

var. **cylindricum** W. & G. S. WEST in Journ. Bot. 41, 40, 1903; Monogr. Brit. Desm.

1, 67, 1904; BORGE Ark. Bot. **23A**, 24, 1930; FUJISAWA Journ. Jap. Bot **10**, 444, 1934.

Cellulae cylindricae et angustiores, apice late rotundo. Long. 87–90μ, Lat. 17–24μ.

Hab. **Hondo**: Mt. Akagi in Kôzuke; Mt. Naeba in Echigo; Kazafuki-kaminota, Mt. Kirigamine (FUJISAWA) in Shinano. (Pl. I. fig. 16)

Distr. Japan, Europe, N. America, S. Africa.

Netrium interruptum (BRÉB.) LÜTKEM. in WEST Monogr. Brit. Desm. 1, 68, 1904; KRIEGER Krypt. Fl. XIII, 1, 222, 1933,

Cellulae magnae, circiter 4–5 longiores quam latae, fusiformes sed lateribus rectis parallelis in medio, subito attenuatis ad polos, polis obtuse rotundis; chromatophoris 2 in unaquaque semicellula et cum lamina longa circa 8 in marginis extremitate glabra. Long. 168–219μ, Lat. 34.4–36.4μ.

Hab. **Hondo**: Chûkawa-ike, Naga-numa of Mazawa in Uzen. (New to Asia) (Pl. II. fig. 1)

Distr. Europe, U. S. A.

var. **minor** (BORGE) KRIEGER in Krypt. Fl. XIII, 1, 223, 1933.

Cellulae minores. Long. 154μ, Lat. 34.4μ.

Hab. **Hondo**: Megata in Ugo. (New to Asia) (Pl. II. fig. 2)

Distr. Germany, U. S. A.

Roya W. & G. S. WEST

in JOURN. Roy. Micr. Soc. 152, 1896; Monogr. Brit. Desm. 1, 106, 1904; WEST & FRITSCH Brit. Alg. 230, 1927; SMITH Freshw. Alg U. S. 308, 1950.

Cellulae elongatae, cylindricae, rectae vel leviter curvatae, leviter attenuatae ad polos, polis truncato- vel obtuse rotundis; chromatophoris singulis axialibus paucis cum lamina longa et cum pyrenoidibus multis centralibus; zygosporae globosae glabrae.

Roya cambrica W. & G. S. WEST in JOURN Bot. 41, 41, 1903; Monogr. Brit. Desm. 1, 108, 1904 , KRIEGER Krypt. Fl. XIII. 1. 206, 1933.

Cellulae mediocres, leviter curvatae, circiter 24–25 plo longiores quam latae, gradatim attenuatae ad apices, apicibus truncatis et leviter rotundis; chromatophoris cum pyrenoidibus 12–24. Long. 168–207μ, Lat. 8–9μ.

Hab. **Hokkaido**: Horomui in Ishikari. **Hondo**: Hirumo-numa in Ugo. (New to Asia) (Pl. II. fig. 8, 9)

Distr. Europe.

Gonatozygaceae

in WEST & FRITSCH Brit. Alg. 240, 1927; KRIEGER Krypt. Fl. XIII, 1, 174, 1933.

Cellulae in filamentos longos laxe connectos formatae, sed facile in cellulas

individuales separatae; cellulae longae, cylindricae non constrictae ad medium; membrana cum poro ornatae, membrana interna hyalina et sine structura, membrana externa granulis vel spinis ordinata; chromatophoris axialibus vel parietalibus, duabus vel tribus in unaquaque semicellula ornatis, pyrenoidibus multis.

Gonatozygon De BARY

in Conj. 26, 1858; WEST Monogr. Brit. Desm. 1, 29, 1904; WEST & FRITSCH Brit. Alg. 241, 1927; Smith Freshw. Alg. U. S. 306, 1950.

Cellulae cylindricae, multo longiores quam latiores, non constrictae, lateribus generaliter rectis parallelis sed ad apicem leviter dilatatis vel convergentibus, apicibus truncatis; membrana glabra, granulata vel multospinulata; chromatophoris axialibus, bractea-formibus, a polo ad polum extensis, pyrenoidibus nonnullis in seriebus axialibus ordinatis; cellulae in filamentos longos conjunctae sed laxe separatae; zygosporae sphaericae glabrae.

1a. Membrana granulata.
  2a. Cellulae cylindricae non attenuatae ad apices..... **G. monotaenium**
  2b. Cellulae subfusiformes, attenuatae ad apices, apice capitato..... **G. Brébissonii**
1b. Membrana spinulata.
  2a. Spina minuta, cellulis 12–13μ in longitudinem..... **G. pilosum**
  2b. Spina acuta et valida, cellulis 7–12μ in longitudinem.
    3a. Cellulae 14μ in latitudinem..... **G. aculeatum**
    3b. Cellulae 11–12μ in latitudinem..... var. **gracile**

Gonatozygon monotaenium De BARY in WEST Monogr. Brit. Desm. 1, 30, 1904; SMITH Wisc. Bull. 57, 5, 1924; FUJISAWA Journ. Jap. Bot. 10, 441, 1934; OKADA Imp. Fish. Inst. 30, 137, 1934; YAMAGUCHI & HIRANO Act. Phytotax. Geobot. 15, 146, 1954.

Cellulae longae, cylindricae, circiter 18–20 longiores quam latae sine granulis, prope apicem leviter dilatatis; membrana granulata, granulis minutis multis; chromatophoris cum pyrenoidibus 6–8. Long. 157–256μ, Lat. 8.6–12.6μ.

Hab. **Hokkaido**: Horomui in Ishikari. **Hondo**: Izu-numa in Rikuzen; Ina in Shinano (FUJISAWA); Tanuki-numa in Suruga; Lake Biwa in Oomi. **Shikoku**: Yamauchi-mura in Sanuki. **Kiushiu**: Lake Ikeda, Kagami-ike in Satsuma. (Pl. I. fig. 1)

Distr. Japan, the Kuriles, China, Ceylon, Thailand, Burma, Sumatra, Europe, Greenland, U. S. A., W. India, New Caledonia.

Gonatozygon Brébissonii De BARY in WEST Monogr. Brit. Desm. 1, 31, 1904; MIGULA Krypt. Fl. II, 559, 1907; HOMFELD Pflanzenf. 12, 13, 1929; HIRANO Act. Phytotax. Geobot. 14, 138, 1952.

Cellulae parvae, subfusiformes, circiter 18–20 longiores quam latae, apicibus subcapitatis; membrana dense granulata, granulis minutis; chromatophoris cum pyrenoidibus 5–6. Long. 160μ, Lat. 7.8μ.

Hab. **Hondo**: Takashihara in Mikawa; Lake Shôji in Kai. (Pl. I. fig. 2, 3)

Distr. Japan, Manchuria, Siberia, S. China, India, Ceylon, Europe, Spitzbergen, Greenland, N. America, S. Africa.

Gonatozygon pilosum WOLLE in Bull. Torrey Bot. Club 27, 1882; Desm. U. S. 32, 1384; YAMAGUCHI Rep. Limn. Surv. Kwant. 483, 1940.

Cellulae modicae, longae, cylindricae, circiter 12–13 longiores quam latae, leviter dilatatae prope apicem, apicibus rectis; membrana spinulata, cum multis spinis minutis. Long. 180μ, Lat. 15.4μ.

Hab. **Hondo**: Nukigawa of Lake Biwa in Oomi; Ikejiri-ike in Tanba. (New to Japan) (Pl. I. fig. 6)

Distr. Manchuria, Siberia, China, India, Ceylon, Java, British Isles, U. S. A.

Gonatozygon aculeatum HAST. in JOHNSON Bull. Torrey Bot. Club 22, 291, 1895; WEST Trans. Roy. Soc. Edinburgh. 41, 498, 1905; SMITH Wisc. Bull. 57, 5, 1924; ALLORGE Rev. Alg. 5, 342, 1930.

Cellulae longae, cylindricae, circiter 10–12 longiores quam latae sine spinis, lateribus parallelis rectis, apicibus truncatis et leviter rotundis; membrana valide spinulata, spinis parvis acutis erectis; chromatophoris cum pyrenoidibus 6–9. Long. 146μ, Lat. sine spin. 14μ, Long. spin. 6μ.

Hab. **Hondo**: Ozegahara in Kôzuke; Kizaki in Shinano; Fuse-ike, Shinohara-ike in Oomi. (Pl. I. fig. 4)

Distr. Europe, U. S. A., Brazil, S. Africa.

var. **gracile** GRÖNBL. in Act. Soc. Faun. Flor. Fenn. 47, 11, 1920; HIRANO Act. Phytotax. Geobot. 14, 101, 1950.

Cellulae minores et angustiores, circiter 7–8 longiores quam latae, spinis relative longis. Long. 100–163μ, Lat. 12–17μ.

Hab. **Hokkaido**: Junsai-numa in Oshima. **Hondo**: Mizoroga-ike in Yamashiro. **Kiushiu**: Lakes Ikeda and Unagi in Satsuma. (Pl. I. fig. 5)

Distr. Japan, Finland.

Desmidiaceae

in OLTMANNS Morph. Biol. Alg. 1, 106, 1922; WEST & FRITSCH Brit. Alg. 253, 1927; SMITH Freshw. Alg. U. S. 310, 1950 —— *Placodermeae* LÜTKEM. in WEST Monogr. Brit. Desm. 1, 70, 1904.

Cellulae solitares vel coloniae, coloniae filamentibus vel sphaericis ramulis cum solida filorum gelatina conjunctis; cellulae generaliter nudae sed aliquando in hyalina gelatinosa protectae, gelatinis hyalinis homogeneis vel fibrillaribus, cellulae variabiles, generaliter constrictae ad medium vel non constrictae, in semicellulas symmetrices binas divisiae; membrana interna glabra, membrana externa crassa et firma cum structura poriforme, in parte externa cum signis regularibus et caracteristici; chro-

matophoris generaliter axialibus, singulis in unaquaque semicellula, raro parietalibus, pyrenoidibus singulis vel multis, in centrum sitis; divisio cellularum generaliter fiunt in definito loco, saepe ad isthmum fiunt, semicellulae novae in punctum divisionis efficientur et itaque cellulae ea novis et antiquis semicellulis compositae in pauca genera fiunt principium divisionis cellularum ab indefinita positione in definito typo; nucleis singulis in centro cellularum ad isthmum sitis.

Systema desmidiacearum

1a. Punctula divisionis cellularum variabilia sed aliquando fixa ad isthmum.
2a. Cellulae relative breves vel mediocres, rectae aliquando leviter constrictae; punctulis divisionis cellularum aliquando valiabilis ..... **Penieae**
Genera unica ..... **Penium**
2b. Cellulae elongatae, generaliter curvatae et attenuatae ad apicem, non constrictae, punctulis divisionis cellularum in medium sitis ..... **Closterieae**
3a. Polus cellularum sine spinis ..... **Closterium**
3b. Polus cellularum cum spinis ..... **Spinoclosterium**
1b. Punctula divisionis cellularum ad isthmum fixa; cellulae forma variabiles, generaliter constrictae in medio ..... **Cosmarieae**
2a. Cellulae solitariae, separatae post divisionem cellularum.
3a. Cellulae elongatae, cylindricae, paullo constrictae in medio.
4a. Apicibus cellularum truncatis vel rotundis.
5a. Basis semicellularum plicata ..... **Docidium**
5b. Basis semicellularum glabra ..... **Pleurotaenium**
4b. Apicibus cellularum fissura ornatis, incisuris apicalibus apertis vel angustis.
5a. Membrana cum verticillis ornata ..... **Triploceras**
5b. Membrana glabra sine annulo processus furcati.
6a. Incisura mediana apicalis late aperta, angulis apicalibus spina ornatis. ..... **Ichthyocercus**
6a. Incisura mediana apicalis angusta linea, angulis sine spina ..... **Tetmemorus**
3b. Cellulae relative breves, in vertice visis ellipticae vel radiales, constrictione mediana generaliter profunda.
4a. Cellulae compressae; in vertice visae generaliter ellipticae vel fusiformes.
5a. Cellulae in margine generaliter integrae, saepe cum spinis vel verrucis ornatae.
6a. Cellulae generaliter plus minusve cum tumore mediano ornatae.
7a. Membrana glabra, granulata vel verrucosa; tumore mediano levo. ..... **Cosmarium**
7b. Membrana cum spinarum pari regulariter disposita ..... **Xanthidium**
6b. Cellulae sine tumore mediano, angulis cum spina ornatae ..... **Arthrodesmus**
5b. Cellulae generaliter cum incisura apicale et tumore mediano ornatae, fere lobatae ..... **Euastrum**
5c. Cellulae summe compressae, incisura apicale late aperta, profunde lobatae. ..... **Micrasterias**
4b. Cellulae in vertice visae radiatae communiter tri-vel quadrangulares, sed plus multo angulares vel raro biradiatae ..... **Staurastrum**
2b. Cellulae coloniae formantes, non separatae post divisionem.
3a. Coloniae sphaericae vel ellipsoides ex fibris gelatinosis conjunctae in perpendiculari directione dispositae ..... **Cosmocladium**
3b. Coloniae filamentosae, cellulae in apices conjunctae.

4a. Cellulae in apices rectos conjunctae.
5a. Cellulae sine zona mediana incrassata ad punctorum divisionem.
6a. Cellulae valide constrictae ..... **Spondylosium**
6b. Cellulae levissime constrictae..... **Hyalotheca**
5b. Cellulae cum zona incrassato-mediana ad punctorum divisionem.
6a. Cellulae multo longiores, in vertice visae circulares ..... **Gymnozyga**
6b. Cellulae breviores, in vertice visae ellipticae vel tri-vel quadrangulares.
..... **Desmidium**
4b. Cellulae processibus apicalibus conjunctae.
5a. Processibus apicalibus summe brevibus..... **Sphaerozosma**
5b. Processibus apicalibus longis et superimpositis apicibus cellulae proximae.
..... **Onychonema**

Penieae LÜTKEM.

in Beitr. Biol. Pflanz. 8, 408, 1902; WEST Monogr. Brit. Des. 1, 71, 1904.

Cellulae modice longae, rectae, cylindricae vel ellipsoides, communiter non constrictae, raro leviter constrictae ad medium; membrana sine poris, generaliter punctata, punctato-striata, vel striata; punctulis divisionis cellularum interdum variabilibus, communiter zona mediana praeditis.

Penium BRÉB.

in RALFS' Brit. Desm. 148, 1848; WEST Monogr. Brit. Desm. 1, 71, 1904; SMITH Wisc. Bull. 57, 7, 1924; WEST & FRITSCH Brit. Alg. 267, 1927; KRIEGER Krypt. Fl. XIII, 1. 226, 1933; SMITH Freshw. Alg. U. S. 318, 1950.

Cellulae longitudine variabiles, generaliter cylindricae, subcylindricae, ellipsoides vel fusiformes, non constrictae vel leviter constrictae ad medium, apicibus rotundis, truncatis vel subtruncatis; membrana glabra, punctata, granulata vel striata, granulis irregulariter vel longitudinaliter ordinatis, incolora vel fucescente; chromatophoris axialibus, cum bractea radiata et longitudinaliter posita et unica in unaquaque semicellula; zygosporae globosae, glabrae vel raro subquadratae.

1a. Cellulae sine sutura mediana.
2a. Membrana crassa et incolora, punctulis in seriebus longitudinalibus ordinatis.
..... **P. silvae nigrae**
2b. Membrana tenues et fusca, punctulis irregulariter ordinatis ..... **P. rufescens**
1b. Cellulae cum sutura mediana.
2a. Membrana punctata.
3a. Cellulae magnae, punctulis leviter seriebus longitudinalibus irregularibus ordinatis.
..... **P. margaritaceum**
3b. Cellulae parvae, punctulis dense et irregulariter ordinatis.
4a. Cellulae leviter constrictae vel retusae in medio, apice capitato..... **P. exiguum**
5a. Apice late rotundo ..... f. **typica**
5b. Apice truncate rotundo ... . var. **glaberrimum**
4b. Cellulae non constrictae vel retusae, apice non capitato ..... P. **cylindrus**
5a. Cellulae magnae, 35–53μ in longitudinem ..... f. **typica**
5b. Cellulae parvae, 19–34μ in longitudinem..... var. **cuticulare**

2b. Membrana striata.
3a. Stria irregulariter ordinata ..... **P. substriatum**
3b. Stria longitudinaliter ordinata ..... **P. polymorphum**
3c. Stria spiraliter ordinata ..... **P. spirostriolatum**

Penium silvae nigrae RABANUS in Hedw. **64**, 229, 1923; KRIEGER Krypt. Fl. XIII' **1**, 239, 1935; HIRANO Act. Phytotax. Geobot. **11**, 283, 1942.

Cellulae mediocres, cylindricae, 2.5–3 longiores quam latae, leviter constrictae in medio, apice late rotundo; membrana crassa dense punctata, seriebus punctorum delicatorum longitudinaliter ornatis et vix visibilibus; chromatophoris axialibus cum laminis longis radiantibus et pyrenoidibus centralibus in unaquaque semicellula. Long. 48–67μ, Lat. 22–28μ.

Hab. **Hondo**: Mt. Hakkoda in Mutsu; Mt. Hachimantai, Mt. Iwate in Rikuchû; Mt. Komagatake, Mt. Kurikoma in Ugo; Mt. Gassan, Mt. Azuma, Mt. Sugigamine of Zawo in Uzen; Nanko in Iwaki; Ozegahara in Kôzuke; Shimizu-daira of Mt. Nasu in Shimotsuke; Mt. Kumono-taira, Tarobei-daira, Kurobegoro-daira, Mt. Tateyama, Mt. Norikura in Etchû; Shibu-ike of Shigakogen, Mt. Kirigamine, Mt. Kazafuki, Tenguno-hara, Happo-ridge, Mt. Sanpogamine in Shinano; Mt. Naeba in Echigo. (Pl. II. fig. 18)

Destr. Japan, Europe.

Penium rufescens CLEVE in WEST Monogr. Brit. Desm. **1**, 99, 1904; PRESCOTT & MAGNOTTA Pap. Mich. Acad. Sci. **20**, 158, 1935; KRIEGER Krypt. Fl. XIII, **1**, 240, 1935; OKADA ASASHINA's Inkwa. 125, 1939.

Cellulae mediocres, cylindricae, circiter 2–2.5 longiores quam latae, levissime constrictae, sinu depresso, apicibus latissime rotundis; membrana subtiliter punctata et rufescens. Long. 56μ, Lat. 25μ.

Hab. **Hondo**: Chûkawa-ike in Uzen. (New to Japan) (Pl. IV. fig. 29)

Distr. Kuriles, Europe, N. America, Brazil.

Penium margaritaceum (EHRENB.) BRÉB in RALFS Brit. Desm. 149, 1848; WEST Monogr. Brit. Desm. **1**, 83, 1904; SMITH Wisc. Bull. **57**, 7, 1924; FUJISAWA Journ. Jap. Bot. **10**, 442, 1934; KRIEGER Krypt. Fl. XIII, **1**, 230, 1935.

Cellulae magnae, cylindricae, circiter 5–8 longiores quam latiores, leviter constrictae in medio, levissime attenuatis ad apices, apice late rotundo; membrana fusco-rufescens et cum sutura mediana, punctata, punctulis nonnihil longa serie irregulari; duobus chromatophoris in unaquaque semicellula cum pyrenoidibus magnis. Long. 106–132μ, Lat. 14–20μ.

Hab. **Hokkaido**: Ko-numa in Oshima; Nakano of Sapporo in Ishikari; Nikuru-numa in Kitami; Toyokoro in Tokachi; Onne-numa in Nemuro. **Hondo**: Kyutai in Mutsu; Kobuchi-numa, Kesho-numa in Rikuzen; Hakuryu-ko in Uzen; Akaiyachi, Kôriyama in Iwashiro; Kashimacho in Iwaki; Kagami-ike of Matsunoyama in Echigo; Ôhanami-ike, Lake Kizaki, Inago of Kitamaki-mura in Shinano; Biwa-ike in Owari;

Kotsutsumi-nishi-ike in Mikawa; Lake Biwa, Matsubara-naiko in Oomi; Shakuhachi-ike in Yamashiro; Ikejiri-ike in Tanba. **Shikoku**: Shiramizu-pass near Matsuyama in Iyo. **Kiushiu**: Imuta-ike, Nakahama of Lake Ikeda in Satsuma. (Pl. II. fig. 5)

Distr. Japan, Manchuria, Siberia, Borneo, Java, Burma, Europe, Kamtshatka, Greenland, S. America, Australia, S. Africa.

Penium exiguum W. WEST in WEST Monogr. Brit. Desm. 1, 86, 1904; ALLORGE Rev. Alg. 5, 344, 1930; KRIEGER Krypt. Fl. XIII, 1, 233, 1935.

Cellulae parvae, circiter 4–5 longiores quam latae, non attenuatae sed leve constrictae in medio, apicibus leviter capitatis et late rotundis; membrana subtiliter et irregulariter punctata; pyrenoidibus 2–3 in unaquaque semicellula. Long. 38–40μ, Lat. 8–9μ.

Hab. **Hondo**: Akaiyachi in Iwashiro; Mt Tateyama in Etchû. (New to Japan) (Pl. II. fig. 15; Pl. VIII. fig. 7)

Distr. Sumatra, Europe, U. S. A.

var. **glaberrimum** GRÖNBL. in KRIEGER Krypt, Fl. XIII, 1, 234, 1935.

Var. apicibus cellularum leviter dilatatis aliquando indistinctis, apice truncato-rotundo. Long. 64.4μ, Lat. 8.4μ.

Hab. **Hondo**: Fuse-ike in Oomi. (New to Asia) (Pl. II. fig. 13)

Distr. Germany.

Penium cylindrus (EHRENB.) BRÉB. in RALFS Brit. Desm. 150, 1848; WEST Monogr. Brit. Desm. 1, 84, 1904; OKADA Imp. Fish. Inst. 30, 140, 1934; KRIEGER Krypt. Fl. XIII, 1, 234, 1935.

Cellulae parvae, cylindricae, cireiter 5 longiores quam latae, ad medium leviter constrictae, marginibus lateralibus rectis et paene parallelis, apice late truncato-rotundis; membrana fine granulata, granulis parvis irregulariter dispositis, fusco-rufescens; chromatophoris cum pyrenoidibus singulis vel duobus in unaquaque semicellula. Long. 28–56μ, Lat. 11–13μ.

Hab. **Hokkaido**: Kiritappu in Kushiro. **Hondo**: Hirumo-numa in Ugo; Chûkawa-ike in Uzen; Nogiwano-kwannon-ike in Iwashiro; Ko-numa of Mt. Akagi in Kôzuke; Mt. Kirigamine in Shinano; Kôridonono-ike in Echigo; Takashihara in Mikawa; Shinohara-ike, Mt. Hira in Oomi; Takaraga-ike in Yamashiro. **Shikoku**: Matsuyama in Iyo, (Pl. IV. fig. 27)

Distr. Siberia, Europe, Greenland, N. & S. America, New Zealand.

var. **cuticulare** W. & G. S. (WEST) KRIEGER in Krypt. Fl. XIII, 1, p. 236, 1935; HIRANO Journ. Jap. Bot. 20, 40, 1944. —— *Penium cuticulare* W. & G. S. WEST in Monogr. Brit. Desm. 1, 85, 1904.

Cellulae minores, circiter 3 longiores; membrana granulata, granulis nonnihil

delicatis et irregulariter dispositis. Long. 28μ, Lat. 9.5μ.

Hab. **Hondo**: Tamaru in Ise. **Kiushiu**: Imuta-ike in Satsuma. (Pl. IV, fig, 26)

Distr. Japan, British Isles.

Penium substriatum HIRANO in Act. Phytotax. Geobot. **12**, 156, 1943.

Cellulae mediocres, cylindricae, circiter 2.5 longiores quam latiores, leviter constrictae, gradatim attenuatis ad apices, apice late rotundo, marginibus lateralibus paene rectis vel leviter cenvexis in medio; membrana fusco-rufescens irregulariter curvato-striata. Long. 62–65μ, Lat. 25–27μ.

Hab. **Hondo**: Kamaga-ike of Kirigamine in Shinano; Mt. Hira in Oomi. (Pl. II. fig. 17)

Distr. Japan.

Penium polymorphum PERTY in LUNDELL Nov. Act. Regn. Soc. Ups. 3, VIII, 86, 1871; WEST Monogr. Brit. Desm. **1**, 90, 1904; KRIEGER Krypt. Fl. XIII. **1**, 229, 1935; HIRANO Act. Phytax. Geobot. **11**, 283, 1942.

Cellulae submediocres, cylindricae vel ellipticae, circiter 2–2.5 longiores quam latae, non constrictae, gradatim attenuatae ad apices, apice late rotundo; membrana striata, striae circiter 15–18 in 10μ visae et in medio rectae sed irregulariter curvatae et divisae prope apices, suturis medianis visibilibus; chromatophoris cum pyrenoidibus magnis centralibus et laminibus longis multis. Long. 44–53μ, Lat. 16–21μ.

Hab. **Hokkaido**: Akan-junsai-numa, Kiritappu in Kushiro. **Hondo**: Mt. Hakkoda, Hachiman-numa of Mt. Hachimantai in Mutsu; Megata, Kawashiri, Koke-numa, Hoso-numa, Mt. Kurikoma in Ugo; Mt. Azuma, Mt. Gassan, Mt. Sugiga-mine, of Zawo in Uzen; Komagatake in Rikuchû; Hibushi-numa in Iwaki; Akaiyachi in Iwashiro; Izu-numa in Rikuzen; Ozegahara, Mt. Akagi, Ômine-numa in Kôzuke; Usagi-shima of Nikko in Shimotsuke; Mt. Naeba, Mt. Myoko in Echigo; Mt. Tateyama, Senninike in Etchû; Shigakogen, Mt. Kirigamine, Mt. Eboshi, Kumono-taira, Tarobei-daira, Kurobegoro-daira, Tsuruga-ike of Mt. Norikura, Tashiro-ike of Kamikochi, Mt. Sanpogamine, Mt. Kazafuki, Ashinota-ike in Shinano; Takashihara, Kotsutsumi-nishi-ike in Mikawa; Fuse-ike in Oomi; Takaraga-ike in Yamashiro. **Shikoku**: Yamada in Tosa. **Kiushiu**: Hirabaru of Yabakei in Bunzen; Imuta-ike in Satsuma. (Pl. II. fig. 19; Pl. IV. fig. 22)

Distr. Japan, Siberia, Java, Sumatra, Borneo, Europe, N. America, New Zealand.

Penium spirostriolatum BARKER in WEST Journ. Linn. Soc. Bot. **34**, 377, 1899; WEST Monogr. Brit. Desm. **1**, 88, 1904; OKADA Imp. Fish. Inst. **30**, 142, 1934; KRIEGER Krypt. Fl. XIII, **1**, 227, 1935; HIRANO Act. Phytotax. Geobot. **11**, 282, 1942.

Cellulae magnae, cylindricae, elongatae, 5–10 longiores quam latae, non constrictae sed prope sutura leviter emarginatae, gradatim attenuatae versus apices, apice rotundo; membrana lutea vel fusca, striata, striis spiraliter dispositis et circa 4 in

10μ, sutura mediana parvas trans cellulam, inter strias densa punctatio; duobus chromatophoris in unaquaque semicellula et 7 laminis longis et pyrenoidibus singulis centralibus. Long. 154–207μ, Lat. 15–23μ.

Hab. **Hokkaido**: Horomui in Ishikari; Toyokoro in Tokachi; Kiritappu in Kushiro; Chôbushi-numa in Nemuro. **Hondo**: Hoso-numa, Ogata in Ugo; Hakuryu-ko, Eboshi-numa, Ôishita in Uzen; Kesho-numa in Rikuzen; Umaushi-numa in Iwaki; Akaiyachi, Nogiwano-kwannon-ike in Iwashiro; Oze-numa in Kôzuke; Tengunohara, Myojin-ike of Kamikochi, moor near Lake Kizaki in Shinano; Kotsutsumi-nishi-ike in Mikawa; Nukigawa of Lake Biwa in Oomi; Tamaru, Jôdo-ike in Ise. **Kiushiu**: Imuta-ike in Satsuma. (Pl. II. fig. 6, 7)

Distr. Kuriles, Java, Sumatra, Ceylon, Europe, N. America, Azores.

Closterieae Lütkem.

in Beitr. Biol. Pflanz. 8, 408, 1902; West Monogr. Brit. Desm. 1, 106, 1904.

Cellulae elongatae generaliter curvatae, non constrictae, generaliter attenuatae versus apices; membrana cum foramine, glabra vel longitudinaliter striata, punctulis divisionis cellularum sitis in medio; zona mediana praesenti vel non praesenti.

Closterium Nitzsch

in Ralfs Brit. Desm. 159, 1848; West Monogr. Brit. Desm. 1, 109, 1904; Smith Wisc. Bull. 57, 8, 1924; West & Fritsch Brit. Alg. 269, 1927; Krieger Krypt. Fl, XIII, 1, 242, 1935; Smith Freshw. Alg. U. S. 316, 1950.

Cellulae elongatae semper leviter attenuatae, generaliter curvatae, valide arcuatae vel lunatae, raro rectae, non constrictae, polis obtusis truncatis vel acutis; membrana glabra, longitudinaliter striata, incolora vel a flavo ad fuscum e colorem; chromatophoris singulis in unaquaque semicellula cum lamina longa; pygrenoidibus paucis vel multis, generaliter in seriebus centralibus raro irregulariter ordinatis; cellulae in sectione transversa circulares; zygosporae globosae, glabrae vel quadratae cum angulis truncatis.

1a. Cellulae rectae, non curvatae; membrana glabra sine sutura mediana. ..... Subgen. **Holopenium**
2a. Cellulae parvae, 3–4 plo longiores quam latiores; pyrenoidibus 1–2 ..... **Cl. navicula**
2b. Cellulae magnae, 5–6 plo longiores quam latiores; pyrenoidibus 3–6 ..... **Cl. libellula**
3a. Chromatophoria divisa ..... var. **interruptum**
3b. Chromatophoria non divisa.
4a. Cellulae magnae, 170–450μ in longitudinem ..... f. **typica**
4b. Cellulae parvae, 75–170μ in longitudinem ..... var. **intermedium**
1b. Cellulae generaliter curvatae; membrana cum vel sine sutura mediana. ..... Subgen. **Euclosterium**
2a. Cellulae sine sutura mediana.
3a. Cellulae leviter curvatae, marginibus internis paene rectis vel leviter concavis.
4a. Membrana glabra.
5a. Cellulae gradatim attenuatae versus apicem.

6a. Cellulae angustae, 4–24μ in latitudinem.
7a. Apice acuto ..... **Cl. acutum**
7b. Apice rotundo.
8a. Margines interni et externi inaequales, margines externi convexi, margine interni recti vel concavi.
9a. Cellulae cum marginibus parallelis in medio ornatae.
10a. Cellulae 4–8μ in latitudinem.
11a. Cellulae 28–40 longiores quam latiores ..... **Cl. gracile**
11b. Cellulae 80–98 longiores quam latiores ..... **Cl. aciculare**
10b. Cellulae 8–20μ in latitudinem ..... **Cl. toxon**
9b. Cellulae sine marginibus parallelis.
10a. Cellulae parvae, circiter 40–160μ in longitudinem ..... **Cl. cornu**
11a. Cellulae parvae, 110–160μ in longitudinem, 12–21 plo longiores quam latiores ..... f. **typica**
11b. Cellulae parvae, 40–85μ in longitudinem, 8–12 plo longiores quam latiores ..... var. **upsaliense**
10b. Cellulae modice longae, circiter 150–330μ in longitudinem.
11a. Cellulae cum leve inflatione mediana ..... **Cl. littorale**
11b. Cellulae sine inflatione mediana.
12a. Cellulae 8–12μ in latitudinem.
13a. Cellulae 140μ in longitudinem ..... **Cl. sinense**
13b. Cellulae 190–350μ in longitudinem ..... **Cl. strigosum**
12b. Cellulae 21 plus in longitudinem ..... **Cl. Johnsonii**
8b. Margines interni et externi aequali ..... **Cl. idiosporum**
6b. Cellulae latae, 37–100μ in latitudinem.
7a. Cellulae 36–70μ in latitudinem; pyrenoidibus in seriebus centralibus dispositis ..... **Cl. lanceolatum**
7b. Cellulae 70–110μ in latitudinem; pyrenoidibus numerosis irregulariter dispositis ..... **Cl. Lunula**
5b. Cellulae rapide attenuatae versus apicem, apice prolongato, parte mediana cellularum distincte inflato ..... **Cl. subulatus** v. **maius**
4b. Membrana punctata.
5a. Puncta dense et irregulariter disposita ..... **Cl. Baillyanum**
5b. Puncta dense et in seriebus longis disposita ..... **Cl. Pritchardianum**
4c. Membrana striata.
5a. Cellulae sine inflatione mediana.
6a. Cellulae gradatim attenuatae versus apicem.
7a. Cellulae recurvatae prope apicem ..... **Cl. praelongum**
7b. Cellulae non recurvatae ..... **Cl. lineatum**
6b. Cellulae subito attenuatae prope apicem ..... **Cl. attenuatum**
5b. Cellulae cum distincta inflatione mediana.
6a. Cellulae rapide attenuatae in processos longos.
7a. Processus elongissimi, angusti et levi, longiores quam corpora cellularum. ..... **Cl. setaceum**
7b. Processus longi et angusti, breviores quam corpora cellularum. ..... **Cl. Kützingii**
6b. Cellulae gradatim attenuatae in processus.
7a. Processus mediocriter longi ..... **Cl. rostratum**
7b. Processus brevi ..... **Cl. Ralfsii**
8a. Cellulae parvae et angustae, 11–25μ in latitudinem ..... var. **gracilius**

8b. Cellulae modice longae, 28–62μ in latitudinem.
9a. Cellulae 12–18 plo longiores quam latiores .....var. **hybridum**
9b. Cellulae 30-35 plo longiores quam latiores .....var. **novae-anguliae**
4d. Membrana costata.....**Cl. lineatum** var. **costatum**
3b. Cellulae valide curvatae.
4a. Membrana glabra.
5a. Apice acuto vel acute rotundo.
6a. Cellulae sine inflatione mediana.
7a. Cellulae angustissimae, 2·5–5μ in latitudinem.....**Cl. acutum** var. **variabile**
7b. Cellulae 6–15μ in latitudinem.
8a. Cellulae parvae, 30–80μ in longitudinem, pyrenoidibus 1–2.
.....**Cl. venus** var. **incurvum**
8b. Cellulae magnae, 85–130μ in longitudinem, pyrenoidibus 2–5.
..... **Cl. parvulum**
9a. Cellulae 7–10 plo longiores quam latiores, 11–15μ in latitudinem.
..... f. **typica**
9b. Cellulae 12–15 plo longiores quam latiores, 7–10μ in latitudinem.
.....var. **angustum**
6b. Cellulae cum inflatione mediana.....**Cl. tumidulum**
5b. Apice acuto sed obliqualiter truncato, cum distincte foramine terminali disposito.
6a. Zygosporae globosae vel irregulariter globosae; cellula generaliter 80–105 × 8–12μ
.....**Cl. calosorum**
7a. Cellulae 7–12 plo longiores quam latiores, 13–18μ in latitudinem.
.....var. **maius**
7b. Cellulae 12–16 plo longiores quam latiores, 5–11μ in latitudinem.
..... var. **brasiliense**
6b. Zygosporae globosae cum spinis vel wartibus dispositae; cellula generaliter 170–310 × 15–30μ..... **Cl. dianae**
7a. Cellulae breves quam 150μ in longitudinem .....var. **minus**
7b. Cellulae longae quam 150μ in longitudinem.
8a. Cellulae angustae, 10–18μ in latitudinem.....var. **pseudodianae**
8b. Cellulae latae, 18–30μ in latitudinem.....f. **typica**
5c. Apice bene rotundo.
6a. Pyrenoidia in seriebus centralibus disposita.
7a. Cellulae sine inflatione mediana.
8a. Cellulae minutae, 15–32 × 4–9μ.....**Cl. pusilum** var. **minus**
8b. Cellulae magnae, 200–370 × 35–55μ.....**Cl. moniliferum**
9a. Margines interni paene recti, interdum leviter convexi ..... f. **typica**
9b. Margines interni concavi, cellula lunati ..... var. **concavum**
7b. Cellulae cum inflatione mediana .....**Cl. Leibleinii**
6b. Pyrenoidia numerosa irregulariter disposita .....**Cl. Ehrenberagii**
7a. Cellulae cum inflatione mediana.....f. **typica**
7b. Cellulae sine inflatione mediana.....var. **atumidum**
4b. Membrana striata .....**Cl. Wallichii**
2b. Cellulae cum sutura mediana.
3a. Cellulae leve curvatae.
4a. Membrana glabra.
5a. Cellulae parvae, 120–200μ in longitudinem.....**Cl. abruptum**
5b. Cellulae magnae, 340–620μ in longitudinem.....**Cl. macilentum**
4b. Membrana punctato-striata .....**Cl. Braunii**

4c. Membrana striata.
5a. Cellulae leve attenuatae ..... **Cl. Ulna**
5b. Cellulae gradatim attenuatae.
6a. Apice late et obliqualiter truncato.
7a. Cellulae 6-14μ in latitudinem ..... **Cl. juncidum**
7b. Cellulae 15-25μ in latitudinem ..... **Cl. intermedium**
7c. Cellulae 27-52μ in latitudinem ..... **Cl. striolatum**
8a. Membrana in parte striata ..... var. **subpunctatum**
8b. Membrana toto striata ..... f. **typica**
6b. Apice truncato-rotundo.
7a. Cellulae angustae, 23-33μ in latitudinem ..... **Cl. macilentum** var. **japonicum**
7b. Cellulae robustae, 32-50μ in latitudinem ..... **Cl. acerosum**
8a. Cellulae non tumidae ..... f. **typica**
8b. Cellulae leviter tumidae ..... var. **tumidum**
6c. Apice conico-rotundo ..... **Cl. turgidum**
7a. Membrana striata.
8a. Cellulae 11-13 longiores quam latiores ..... f. **typica**
8b. Cellulae 15-26 longiores quam latiores ..... var. **Borgei**
7b. Membrana substriata ..... **Cl. didymotocum**
4d. Membrana costata.
5a. Cellulae angustae, 13-18 longiores quam latiores.
6a. Apice rotundo ..... **Cl. angustatum**
6b. Apice obliqualiter truncato ..... **Cl. subjuncidiforme**
5b. Cellulae latae, 6-11 longiores quam latiores ..... **Cl. costatum**
6a. Cellutae 6-8 longiores quam latiores ..... f. **typica**
6b. Cellulae 10-11 longiores quam latiores ..... var. **Westii**
3b. Cellulae valide curvatae.
4a. Membrana glabra.
5a. Cellulae 8-10 longiores quam latiores, apice angusto et rotundo.
..... **Cl. cynthia** var. **Jenneri**
5b. Cellulae 5-6 longiores qnam latiores, apice late rotundo ..... var. **robustum**
4b. Membrana striata.
5a. Apice inflato ..... **Cl. nematodes**
5b. Apice non inflato.
6a. Cellulae parvae, leviter attenuatae; 90-140 × 11-18μ. ..... **Cl. cynthia**
6b. Cellulae magnae, valide attenuatae, 190-270 × 18-28μ ..... **Cl. Archerianum**

Subgen. **Holopenium** (GAY) HIRANO, comb. nov.

Penium BRÉB. sekt. *Holopenium* GAY in PRINTZ in Engl. Pflanzenf. **3**, 353, 1927 (pro parte)

Cellulae rectae, fusiformes, non curvatae, polis rotundis, sine sutura mediana; membrana glabra decolora; zygospora globosa glabra.

Closterium navicula (BRÉB.) LÜTKEM. in KRIEGER Krypt. Fl. XIII, 1, 257, 1935; HIRANO Act. Phytotax. Geobot **11**, 297, 1942.—*Penium navicula* BRÉB in WEST Monogr. Brit. Desm. **1**, 75, 1904.

Cellulae parvae, fusiformes, diametro circiter 4 longiores, non curvatae, lateribus utrique aequaliter convexis, gradatim attenuatis polos versus, polis late rotundis; mem-

brana glabra, achroa, pyrenoidibus 1–2 in serie unica in unaquaque semicellula. Long. 35–84μ, Lat. 11–20μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Toyokoro in Tokachi; Horomui in Ishikari. **Hondo**: Mt. Hakkoda, Kotsutsumi in Mutsu; Hirumo-numa, Megata in Ugo; Eboshi-numa, Hakuryu-ko, Kaibai-ike in Uzen; Kobuchi-numa in Rikuzen; Kagamiishi-mura, Akaiyachi in Iwashiro; Ojiroi in Iwaki; Oze-numa in Kôzuke; Inago, Ôhanami-ike, Lake Kizaki in Shinano; Takashihara in Mikawa; Fuse-ike, Shinohara-ike, Mt. Hira in Oomi; Ariga-ike, Shakuhachi-ike in Yamashiro. **Shikoku**: Yamauchi-mura in Sanuki; Morimatsu in Iyo. **Kiushiu**: Kôgamuta of Aso in Higo. (Pl. IV. fig. 24)

Distr. Japan, Manchuria, Malay, Sumatra, Ceylon, India, Europe, Greenland, Kamchatka, N. & S. America, Hawaii, Australia.

Closterium libellula FOCKE in KRIEGER Krypt. Fl. XIII, 1, 254, 1935; HIRANO Act. Phytotax. Geobot 11, 293, 1942.——*Penium libellula* (FOCKE) NORDST. in WEST Monogr. Brit. Desm. 1, 73, 1904; OKADA Imp. Fish. Inst. 30, 140, 1934.

Cellulae mediocres, circiter 5 longiores quam latiores, non curvatae, fusiformes, gradatim attenuatae polos versus, polis rotundatis vel subtruncato-rotundatis; membrana glabra, achroa, pyrenoidibus 3-4 in unaquaque semicellula. Long. 216-224μ, Lat. 42–48μ.

Hab. **Hokkaido**: Kiritappu, Tokotan in Kushiro; Horomui in Ishikari. **Hondo**: Umaushi-numa in Iwaki; Jiuemon-ike in Kôzuke. **Shikoku**: Morimatsu in Iyo. **Kiushiu**: Ahira in Ôsumi. (Pl. IV. fig. 21)

Distr. Japan, Kuriles, Korea, China, Malay, Ceylon, Sumatra, Java, Europe, Greenland, N. America, Brazil, New Zealand, E. Africa.

var. **interruptum** (W. & G. S. WEST) DONAT in PFLANZENF. 5, 7, 1926; KRIEGER Krypt. Fl. XIII, 1, 256, 1935; HIRANO Act. Phytotax. Ceobot. 11, 294, 1942. —— *Penium libellula* (FOCKE) NORDST. var. *interruptum* W. & G. S. WEST in Monogr. Brit. Desm. 1, 74, 1904; FUJISAWA Journ. Jap. Bot. 10, 444, 1934.

Cellulae parviores quam in forma typica; chromatophorus singulus transverse divisus; 4 axiles, chromatophori in serie longitudinali dispositi in unaquaque cellula. Long. 151–271μ, Lat. 25–31μ.

Hab. **Hondo**: Hoso-numa in Ugo; Kaibai-ike in Uzen; Umaushi-numa in Iwaki; Oze-numa in Kôzuke; Nenbutsu-ike in Shinano; Kotsutsumi-nishi-ike in Mikawa; Fuse-ike in Oomi. (Pl. IV. fig. 20)

Distr. Japan, Malay, Sumatra, Ceylon, Europe, U. S. A.

var. **intermedium** (ROY & BISSET) G. S. WEST in KRIEGER Krypt. Fl. XIII, 1, 255, 1935; HIRANO Act. Phytotax. Geobot. 11, 293, 1942.——*Penium libellula* (FOCKE) NORDST. var. *intermedium* ROY & BISSET in WEST Monogr. Brit. Desm. 1, 74, 1904; FUJISAWA Journ. Jap. Bot. 10, 441, 1934.

Cellulae dimidiores quam in forma typica, pyrenoidibus 3 in unaquaque semicellula. Long. 123–132μ, Lat. 20–26μ.

Hab. **Hokkaido:** Kiritappu in Kushiro; Chôbushi-numa in Nemuro; Toyokoro in Tokachi; Nikuru-numa in Kitami; Shiraoi-poruto-numa, Tomakomai in Iburi; Horomui, Nakano of Sapporo in Ishikari. **Hondo:** Kurobo-numa, Mt. Hakkoda, Benze-numa in Mutsu; Hoso-numa, Hirumo-numa, Nishi-numa, Megata, Kotomo-numa, Moritake-ôtsutsumi, Kariwano in Ugo; Hakuryu-ko, Tamamushi-numa, Kaibai-ike, Ôishita, Chûkawa-ike in Uzen; Izu-numa, Kesho-numa, Kirifushi-numa in Rikuzen; Kagami-ishi-mura, Akaiyachi in Iwashiro; Nanko, Ojiroi, Kashima-cho, Umaushi-numa in Iwaki; Oze-numa, Ozegahara, Mt. Akagi, Ômine-numa in Kôzuke; Sanpoji-ike in Musashi; Kôridono-ike in Echigo; Daimon-pass, Mt. Kirigamine, Inago, Happo-ridge, Ôhanami-ike, Lake Kizaki in Shinano; Kotsutsumi-nishi-ike, Takashihara in Mikawa; Mt. Hichimenzan in Kai; Tanuki-numa in Suruga; Mt. Hira, Fuse-ike, Shinohara-ike in Oomi; Tamaru, Ishigaki-ike, Kanashôzu in Ise; Mizoroga-ike, Takaraga-ike in Yamashiro. **Shikoku:** Yamada in Tosa. **Kiushiu:** Hirabaru of Yabakei in Bunzen; Mt. Ôhata of Kirishima in Hiuga; Ahira in Ôsumi; Imuta-ike in Satsuma. (Pl. IV. fig. 19)

Distr. Japan, Siberia, Java, Sumatra, Malay, Europe, New Foundland, Brazil, New Zealand, E. Africa.

Subgen. **Euclosterium** (WILLE) HIRANO, comb. nov.

Closterium NITZSCH sekt. *Euclosterium* WILLE in PRINTZ Engl. Pflanzen-fam. 3, 353, 1927. (pro parte)

Cellulae elongatae, curvatae; membrana cum vel sine sutura mediana, glabra, striata vel costata, flavescens vel rufescens; zygospora globosa glabra vel raro quadrata cum angulis truncatis vel conicis irregulariter ordinata.

Closterium acutum BRÉB. in CUSHMAN Bull. Torrey Bot. Club 35, 128, 1908; ALLORGE Rev. Alg. 5, 344, 1930; KRIEGER Krypt. Fl. XIII, 1, 259, 1935.

Cellulae parvae, diametro circiter 25–26 plo longiores quam latiores, leviter curvatae, gradatim attenuatae ad polos, non tumidae in medio, lateribus internis concavis, polis acutis; membrana glabra, achroa, pyrenoidibus 2–4 in serie unica in unaquaque semicellula. Long. 92–176μ, Lat. 4.8–8.4μ.

Hab. **Hokkaido:** Kiritappu in Kushiro. **Hondo:** Ôishita in Uzen; Kitaura in Hitachi; Onjaga-ike, Hakkaku-ike in Kazusa. **Shikoku:** Shiramizu-pass near Matsuyama in Iyo. (New to Japan) (Pl. IV. fig. 25)

Distr. Manchuria, China, Europe, U. S. A., E. Africa.

var. **variabile** (LEMM.) KRIEGER in Krypt. Fl. XIII, 1, 262, 1953.

In var. cellulae tenues, circiter 23 plo longiores, valde curvatae, curvis varia-

bilibus. Long. 150μ, Lat. 6.5μ.

Hab. **Hondo**: Numano-taira of Mt. Bandai in Iwashiro. (New to Asia) (Pl. III. fig. 2)

Distr. Germany, Denmark, Italy.

Closterium gracile BRÉB. in RALFS Brit. Desm. 221, 1848; WEST Monogr. Brit. Desm. 1, 166, 1904; OKADA Imp. Fish. Inst. 30, 145, 1934; KRIEGER Krypt. Fl. XIII, 1, 310, 1935; HIRANO Act. Phytotax. Geobot. 11, 291, 1942.

Cellulae parvae, tenues, circiter 40 longiores quam latiores, levissime attenuatae et curvatae ad polos, polis obtuso-rotundatis, marginibus lateralibus in medio rectis et parallelis; membrana glabra, achroa vel luteo-fuscescente, pyrenoidibus in serie unica in semicellula. Long. 115–272μ, Lat. 4–7μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Toyokoro in Tokachi; Horomui in Ishikari; Tomakomai in Iburi; Yasuushi in Teshio. **Hondo**: Mt. Iwaki in Mutsu; Megata in Ugo; Chûkawa-ike, Ôishita in Uzen; Izu-numa, Naga-numa in Rikuzen; Ojiroi in Iwaki; Akaiyachi, Nogiwano-kwannon-ike, Hôzawa-ike in Iwashiro; Ozegahara in Kôzuke; Senjôgahara in Shimotsuke; Kamikôchi, Karuisawa, Kizaki in Shinano; Lake Biwa, Matsubara-naiko in Oomi; Mizoroga-ike, Shakuhachi-ike in Yamashiro. **Shikoku**: Matsuyama, Morimatsu in Iyo; Yamada in Tosa. **Kiushiu**: Yabakei in Bunzen; Miyazaki in Hiuga; Ahira in Ôsumi; Imuta-ike in Satsuma. (Pl. VI. fig. 8–10)

Distr. Japan, Kuriles, Manchuria, Siberia, China, Thailand, Sumatra, Ceylon, Asia Minor, Europe, Iceland, Greenland, N. & S. America, New Zealand, Australia, E. Africa.

Closterium aciculare T. WEST in WEST Monogr. Brit. Desm. 1, 174, 1904; KRIEGER Krypt. Fl. XIII, 1, 265, 1935; HIRANO Act. Phytotax. Geobot. 15, 22, 1953; —— var. *subpronum* W. & G. S. WEST in Monogr. Brit. Desm. 1, 175, 1904; SMITH Wisc. Bull. 57, 11, 1924.

Cellulae elongatae et tenues, circiter 73–134 plo longiores quam latiores, levissime curvatae et gradatim attenuatae ad polos, polis subacutis, marginibus lateralibus parallelis in medio; membrana glabra, achroa, pyrenoidibus ca. 20 in unaquaque semicellula. Long. 430–580μ, Lat, 5–7μ. (Pl. IX. fig. 1)

Hab. **Hokkaido**: Lake Akan in Kushiro. **Hondo**: Lake Biwa in Oomi.

Distr. Japan, Siberia, Sumatra, Europe, N. America, Argentine, Australia, New Zealand.

Closterium toxon W. WEST in Journ. Linn. Soc. Bot. 29, 121, 1892; WEST Monogr. Brit. Desm. 1, 160, 1904; KRIEGER Krypt. Fl. XIII, 1, 310, 1935; YONEDA Act. Phytotax. Geobot. 8, 131, 1939.

Cellulae mediocres, elongatae, circiter 25–32 longiores quam latiores, leviter curvatae, gradatim attenuatae ad polos et curvatae, medio recto et fere parallelo, polis

subacuto-rotundatis; membrana glabra, achroa, chromatophoris cum 5–7 pyrenoidibus in serie unica in unaquaque semicellula. Long. 240–350μ, Lat. 8.4–11μ.

Hab. **Hokkaido**: Nakano, Moere-numa in Ishikari. **Hondo**: Kurobo-numa in Mutsu; Ô-numa of Mt. Hachimantai in Rikuchû; Kariwano in Ugo; Mt. Azuma, Hakuryu-ko, Tamamushi-numa in Uzen, Izu-numa, Naga-numa, Kesho-numa in Rikuzen; Nanko, Umaushi-numa in Iwaki; Kôriyama, Akaiyachi in Iwashiro; Senjôgahara in Shimotsuke; Shigakogen, Karuisawa in Shinano; Kotsutsumi-nishi-ike, Suhara-ike in Mikawa; Shinohara-ike, Fuse-ike, Nukigawa of Lake Biwa in Oomi; Ariga-ike in Yamashiro; Kanashôzu, Tamaru, Jôdo-ike in Ise. **Shikoku**: Yamauchi-mura in Sanuki. **Kiushiu**: Yabakei in Bunzen; Miyazaki in Hiuga; Nakahara-ike of Fukiagenohama, Nakahama of Lake Ikeda in Satsuma. (Pl. IV. fig. 15, 16)

Distr. Japan, Korea, S. China, Malay, Europe, N. America.

Closterium cornu EHRENB. in RALFS Brit. Desm. 176, 1848; WEST Trans. Roy. Irish Acad. **32B**, 25, 1902; Monogr. Brit. Desm. 1, 157, 1904; KRIEGER Krypt. Fl. XIII, 1, 269, 1935.

Cellulae parvae, diametro circiter 16–17 longiores quam latiores, leviter curvatae, in medio tumidae, gradatim attenuatae ad polos, polis obtusis, lateribus internis prope rectis, lateribus externis convexis; membrana glabra et achroa sine zona mediana; chromatophoris cum 3–4 pyrenoidibus in serie unica in unaquaque semicellula. Long. 152–211μ, Lat. 7.8–13μ.

Hab. **Hokkaido**: Nakano of Sapporo in Ishikari. **Hondo**: Ogata in Ugo; Nukigawa of Lake Biwa in Oomi. **Kiushiu**: Hirabaru of Yabakei in Bunzen. (Pl. IV. fig. 8)

Distr. Japan, Java, Sumatra, Thailand, Europe, N. & S. America, Africa, New Zealand, Australia.

var. **upsaliense** NORDST. in KRIEGER Krypt. Fl. XIII, 1, 270, 1935.

Cellulae parviores et breviores quam in forma typica, circiter 9 longiores, lateribus internis fere rectis. Long. 86μ, Lat. 9.5μ.

Hab. **Hondo**: Izu-numa in Rikuzen. (New to Asia) (Pl. VIII. fig. 11)

Distr. Switzerland, Germany, Sweden.

Closterium littorale GAY in WEST Monogr. Brit. Desm. 1, 155, 1904; KRIEGER Krypt. Fl. XIII, 1, 298, 1935; HIRANO Act. Phytotax. Geobot. **11**, 295, 1942.

Cellulae subparvae, 10–12 longiores quam latiores, leviter curvatae, gradatim attenuatae ad polos, polis obtuso-rotundatis, lateribus internis fere rectis vel leviter tumidis in medio; membrana glabra, achroa; chromatophoris singulis cum 5–7 pyrenoidibus in serie unica. Long. 154–280μ, Lat. 15–34μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Toyokoro in Tokachi. **Hondo**: Mt. Hakkoda, Kurobô-numa in Mutsu; Ôyachi of Mt. Hachimantai in Rikuchû; Nishinuma, Hirumo-numa, Megata, Kariwano, Mt. Kurikoma in Ugo; Mt. Azuma, Eboshinuma, Hakuryu-ko, Mt. Gassan, Naga-numa of Hijiori, Naga-numa of Mazawa in Uzen;

Izu-numa in Rikuzen; Ozegahara in Kôzuke; Senjôgahara in Shimotsuke; Goda-numa in Simofusa; Mt. Naeba, Mt. Myôko, Kôridono-ike in Echigo, Mt. Kirigamine, Inago of Kitamaki-mura, Happo-ridge, Mt. Kazafuki, Shirouma-ôike, Ashinota-ike, Lake Kizaki in Shinano; Mt. Tateyama, Gakinotanbo in Etchû; Tanuki-numa in Suruga; Biwa-ike in Owari; Kotsutsumi-nishi-ike in Mikawa; Jôdo-ike in Ise; Nukigawa, Fuse-ike, Shinohara-ike, Matsubara-naiko, Mt. Hira in Oomi; Mizoroga-ike, Ariga-ike, Shakuhachi-ike in Yamashiro. **Kiushiu**: Bôgatsuru of Mt. Kujû in Bungo; Ahira in Ôsumi. (Pl. IV. fig. 17, 18)

Distr. Japan, S. China, Europe, U. S. A., Central Africa.

Closterium sinense LÜTKEM. in Ann. k. k. Nat. Hist. Hofm. **15**, 116, 1900, KRIEGER Krypt. Fl. XIII, 1, 309, 1935.

Cellulae parvae, circiter 8–12 longiores quam latiores, modice curvatae, gradatim attenuatae ad polos, polis late rotundis, lateribus internis concavis, non tumidis in medio; membrana glabra et incolora; chromatophoris cum pyrenoidibus 4 in serie unica in unaquaque semicellula. Long. 160–192μ, Lat. 15.4–19.6μ.

Hab. **Hondo**: Mt. Hachimantai in Mutsu; Ô-numa in Uzen; Mt. Hira in Oomi. **Kiushiu**: Yabakei in Bunzen. (Pl. III. fig. 5)

Distr. Japan, China.

Closterium strigosum BRÉB. in WEST Monogr. Brit. Desm. 1, 165, 1904; KRIEGER Krypt. Fl. XIII, 1, 299, 1935. ——*Closterium peracerosum* GAY in WEST Monogr. Brit. Desm. 1, 154, 1904.

Cellulae parvae, circiter 10–18 longiores quam latiores, paullulo curvatae, gradatim attenuatae ad polos, polis acuto-rotundis, lateribus internis concavis non tumidis in medio; membrana glabra et incolora. Long. 112–210μ, Lat. 11.2μ.

Hab. **Hondo**: Kobuchi-numa in Rikuzen; Fuse-ike, Matsubara-naiko, Nukigawa in Oomi. **Shikoku**: Matsuyama in Iyo. (New to Japan) (Pl. IV. fig. 9)

Distr. Siberia, Sumatra, Pamir, Europe, N. America, Australia, Africa, Brazil.

Closterium Johnsonii W. & G. S. WEST in Journ. Linn. Soc. Bot. **33**, 284, 1898; KRIEGER Krypt. Fl. XIII, 1, 309, 1935.

Cellulae mediores, leviter curvatae, diametro circiter 17 longiores quam latiores, gradatim attenuatae ad polos, polis anguste et truncato-rotundis, lateribus internis non tumidis in medio, paene parallelis; membrana glabra, incolora. Long. 368μ, Lat. 21μ.

Hab. **Shikoku**: Yamauchi-mura in Sanuki. (New to Asia) (Pl. IX. fig. 2)

Distr. U. S. A.

Closterium idiosporum W. & G. S. WEST in Journ. Bot. **38**, 290, 1900; Monogr. Brit. Desm. 1, 180, 1904; SCHULZ Bot. Arch. 2, 122, 1922; KRIEGER Krypt. Fl. XIII, 1, 271. 1935.

Cellulae submediocres, graciles et elongatae, diametro circiter 20–26 longiores, leviter curvatae, gradatim attenuatae, levissime incurvatae ad polos, polis acute et

leviter rotundatis, medio cellulae prope recto, elongato-fusiformi, marginibus lateralibus aequaliter convexis; membrana glabra, achroa, pyrenoidibus 3–6 in serie centrali in unaquaque semicellula. Long. 240–312μ, Lat. 9.8–11.2μ.

Hab. **Hokkaido**: Nikuru-numa in Kitami; Horomui in Ishikari. **Hondo**: Akaiyachi, Nogiwano-kwannon-ike in Iwashiro; Ashinota-ike, Kizaki in Shinano; Takashihara in Mikawa; Fuse-ike in Oomi; Mizoroga-ike, Shakuhachi-ike, Hirosawa-ike in Yamashiro. **Shikoku**: Shiramizu-pass near Matsuyama in Iyo; Yamada in Tosa. (New to Asia) (Pl. VII. fig. 2)

Distr. Europe.

Closterium lanceolatum KÜTZ. in RALFS Brit. Desm. 164, 1848; WEST Monogr. Brit. Desm. 1, 149, 1904; FUJISAWA Journ. Jap. Bot. 10, 442, 1934; KRIEGER Krypt. Fl. XIII, 1, 319, 1935.

Cellulae submagnae, circiter 6–8 longiores quam latiores, levissime curvatae, gradatim attenuatae polos versus, polis rotundatis, lateribus internis fere rectis vel leviter convexis; membrana glabra et achroa; laminae chromatophori circiter 8–10 et pyrenoidibus 6–8 in serie centrali in unaquaque semicellula. Long. 240–440μ, Lat. 30–52μ.

Hab. **Hondo**: Ogata, Koke-numa in Ugo; Izu-numa in Rikuzen; Nenbutsu-ike of Togakushi in Shinano; Ariga-ike in Yamashiro. **Shikoku**: Dôgo in Iyo. (Pl. IV. fig. 10)

Distr. Japan, Siberia, China, Manchuria, Pamir, Java, Europe, N. America, Argentine, Africa, Madagascar, New Zealand.

Closterium Lunula (MÜLL.) NITZSCH. in RALFS Brit. Desm. 163, 1848; ROY & BISS. Journ. Bot. 24, 240, 1886; WEST Monogr. Brit. Desm. 1. 150, 1904; KRIEGER Krypt. Fl. XIII, 1, 301, 1935; YONEDA Act. Phytotax. Geobot. 8, 131, 1939.

Cellulae magnae, fere rectae, similes Netrio, diametro 5–8 longiores, gradatim attenuatae ad polos, polis obtuso-rotundatis et leviter recurvatis, lateribus internis fere rectis vel leviter convexis, lateribus externis convexis; membrana glabra, achroa; chromatophoris cum pyrenoidibus numerosis irregulariter dispositis. Long. 430–552μ, Lat. 73–89μ.

Hab. **Hokkaido**: Nikuru-numa in Kitami; Chôbushi-numa in Nemuro; Shiraoi-poruto-numa in Iburi. **Hondo**: Suiren-numa of Mt. Hakkoda in Mutsu; Ô-numa of Mt. Hachimantai in Rikuchû; Hakuryu-ko in Uzen; Akaiyachi, Numano-taira of Mt. Bandai in Iwashiro; Gakinotanbo in Etchû; Inago, Togakushi, Daimon-pass, Amaga-ike of Mt. Yatsugatake, Myojin-ike of Kamikôchi in Shinano; Kotsutsumi-nishi-ike in Mikawa; Kanashôzu in Ise; Fuse-ike in Oomi; Ko-ike in Yamashiro. **Kiushiu**: Ahira in Ôsumi. (Pl. IX. fig. 6,7)

Distr. Japan, Siberia, China, Europe, Nova Zembla, Greenland, N. & S. America, New Zealand, Africa.

Closterium subulatus (KÜTZ.) BRÉB. var. **maius** KRIEGER in Krypt. Fl. XIII,

1, 263, 1935.

Cellulae maiores quam in forma typica. Long. 304–323μ, Lat. 15μ.

Hab. **Hondo**: Hirumo-numa in Ugo; Ko-ike in Yamashiro. **Kiushiu**: Hirabaru of Yabakei in Bunzen. (Pl. IV. fig. 5, 6)

Distr. Japan, Germany.

Closterium Baillyanum BRÉB. in KRIEGER Krypt. Fl. XIII, 1, 327, 1935; HIRANO Act. Phytotax. Geobot. 11, 287, 1942.

Cellulae magnae, circiter 10 longiores quam latiores, sensim curvatae, gradatim attenuatae ad polos, polis late et truncato-rotundatis, lateribus externis leviter convexis, lateribus internis rectis; membrana luteola vel fuscescente praecipue infra polos, delicatissime punctata sed valide porosa infra polos; pyrenoidibus 5–7 in serie unica in unaquaque semicellula. Long. 432–736μ, Lat. 42–48μ.

Hab. **Hokkaido**: Nikuru-numa in Kitami. **Hondo**: Suiren-numa of Mt. Hakkoda in Mutsu; Mt. Komagatake in Ugo; Ôishita in Uzen; Ozegahara in Kôzuke; Mt. Kaminotake in Etchû; Daimon-pass, Mt. Kirigamine, Shigakogen, Karuisawa, Happo-ridge in Shinano; Mt. Hira, Nukigawa in Oomi; Tamaru in Ise; Mizoroga-ike, Ariga-ike in Yamashiro. **Kiushiu**: Hirabaru of Yabakei in Bunzen. (Pl. V. fig. 5)

Distr. Japan, N. Kuriles, India, Europe, Greenland, Faroes, U. S. A., Brazil, Africa.

Closterium Pritchardianum ARCH. in DICK Krypt. Forsch. 1, 237, 1919; KRIEGER Krypt. Fl. XIII, 1, 321, 1935.

Cellulae magnae, diametro circiter 13–14 longiores quam latiores, leviter curvatae, non tumidae, gradatim attenuatae ad polos, polis citius attenuatis juxta apicem, leviter recurvatis et anguste truncatis, lateribus internis leviter concavis vel quasi rectis, lateribus externis convexis; membrana fucescente, punctato-striata, punctulis irregulariter dispositis juxta apicem. Long. 462μ, Lat. 35.7μ.

Hab. **Hondo**: Izu-numa in Rikuzen; Nukigawa in Oomi. **Kiushiu**: Nakahama of Lake Ikeda in Satsuma. (New to Japan) (Pl. VI. fig. 14, 15)

Distr. Siberia, Manchuria, Mongolia, Malay, Pamir, Europe, N. & S. America, Africa, Madagascar, Hawaii.

Closterium praelongum BRÉB. in WEST Monogr. Brit. Desm. 1, 164, 1904; BORGE Ark. Bot. 28A, 29, 1936; KRIEGER Krypt. Fl. XIII, 1, 323, 1935; HIRANO Act. Phytotax. Geobot. 15, 22, 1953.

Cellulae modicae, angustae et elongatae, diametro circiter 22–24 longiores quam latiores, leviter curvatae, gradatim attenuatae ad polos, polis leviter recurvatis, extremitatibus obtusis et rotundis, lateribus in medio fere parallelis et non inflatis; membrana lutea, glabra et saepe fine striata, striis alte magnificis; chromatophoris cum pyrenoidibus circa 7–10 in unaquaque semicellula. Long. 470–678μ, Lat. 19–22μ.

Hab. **Hokkaido**: Okineppe in Nemuro; Nikuru-numa in Kitami. **Hondo**:

Ogata in Ugo; Izu-numa in Rikuzen; Goda-numa in Shimofusa; Hakkaku-ko in Kazusa; Lake Nakatsuna in Shinano; Lake Biwa in Oomi. (Pl. IX. fig. 4, 5)

Distr. Japan, Siberia, Manchuria, Thailand, Europe, N. & S. America, Australia.

Closterium lineatum EHRENB. in RALFS Brit. Desm. 173, 1848; ROY & BISSET Journ. Bot. **24**, 240, 1886; WEST Monogr. Brit. Desm. **1**, 181, 1904; FUJISAWA Journ. Jap. Bot. **10**, 442, 1934; KRIEGER Krypt. Fl. XIII, **1**, 349. 1935; HIRANO Act. Phytotax. Geobot. **11**, 295, 1942.

Cellulae magnae, elongatae et tenues, circiter 14 longiores quam latiores, leviter curvatae, gradatim attenuatae ad polos, polis truncato-rotundis, et cum poris terminalibus, lateribus internis leviter concavis vel rectis in medio; membrana lutea, delicatissime striata, striis ca. 12 visis in 10μ; chromatophoris cum 9–11 pyrenoidibus in serie unica in unaquaque semicellula. Long. 448–672μ, Lat. 20–48μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Nikuru-numa in Kitami; Toyokoro in Tokachi; Tomakomai in Iburi. **Hondo**: Koke-numa, Kariwano in Ugo; Akaiyachi, Kagami-ishi-mura in Iwashiro; Ozegahara in Kôzuke; Nenbutsu-ike, Karuisawa, Inago in Shinano; Fuse-ike, Mt. Hira in Oomi; Mizoroga-ike, Takaraga-ike in Yamashiro. **Shikoku**: Shiramizu-pass near Matsuyama in Iyo; Yamauchi-mura in Sanuki. (Pl. VII. fig. 14, 15)

Distr. Japan, Siberia, Java, Sumatra, Ceylon, India, Europe, Mexico, S. America, Australia, E. Africa.

var. **costatum** WOLLE in CUSHMAN Bull. Torrey Bot. Club **35**, 129, 1908; KRIEGER Krypt. Fl. XIII, **1**, 351, 1935.

Cellulae circiter 25–26 duplo longiores; membrana costata, costis 4–5 trans cellulam et inter costas minute punctata. Long. 793–816μ, Lat. 30–32μ.

Hab. **Hondo**: Kotsutsumi-nishi-ike in Mikawa. (New to Asia) (Pl. VII. fig. 13)

Distr. N. America.

Closterium attenuatum EHRENB. in KRIEGER Krypt. Fl. XIII, **1**, 344, 1935.

Cellulae submagnae, diametro circiter 9–10 longiores quam latiores, leviter curvatae, gradatim attenuatae ad polos, polis angustis et obtusis, infra cellulas non tumidis, lateribus internis fere rectis vel leviter concavis; membrana fine striata, cum striis circiter 8–9 in 10μ et continuis punctato-striatis infra apicem; chromatophoris obscuris cum laminis 4 et pyrenoidibus 6–9 in serie centrali in unaquaque semicellula. Long. 340–417μ, Lat. 39–42μ.

Hab. **Hokkaido**: Nikuru-numa in Kitami. **Hondo**: Izu-numa in Rikuzen. **Shikoku**: Yodo-mura is Iyo. (New to Japan) (Pl. VIII. fig. 1)

Distr. Ceylon, Europe, U. S. A.

Closterium setaceum EHRENB. in RALFS Brit. Desm. 170, 1848; ROY & BISSET Journ. Bot. **24**, 240, 1886, WEST Monogr. Brit. Desm. **1**, 122, 1904; KRIEGER Krypt. Fl. XIII, **1**, 337, 1935; HIRANO Act. Phytotax. Geobot. **11**, 301, 1942.

Cellulae subparvae, valde graciles, fere rectae, 30–33 longiores quam latiores, cellulae in medio comparate breves, fusiformes, lateribus utrisque aequaliter convexis, valde graciles, parallelis excrescentiis leviter incurvatis juxta apicem, et extremo obtuso; excrescentiis singulis circiter 1/3—3/8 longioribus quam cellulae; membrana glabra, luteo-pallida, striata, striis delicatis et 7–8 visis; chromatophorus cum 2–3 pyrenoidibus in unaquaque semicellula. Long. 252–528μ, Lat. 8.4–16.8μ.

Hab. **Hokkaido**: Junsai-aka-numa in Oshima; Horomui, Nakano of Sapporo, Moseushi in Ishikari; Tomakomai in Iburi. **Hondo**: Koke-numa, Hirumo-numa, Aka-numa, Moritake-ôtsutsumi, Megata, Kariwano in Ugo; Hakuryu-ko in Uzen; Kobuchi-numa, Izu-numa, Naga-numa in Rikuzen; Akaiyachi in Iwashiro; Umaushi-numa in Iwaki; Kanatsuka-mura in Echigo; Ozegahara Oze-numa in Kôzuke, Kitaura in Hitachi; Daimon-pass, Kizaki, Inago of Kitamaki-mura in Shinano; Kotsutsumi-nishi-ike, Takashihara in Mikawa; Ishigaki-ike, Jôdo-ike in Ise: Nukigawa, Fuse-ike, Matsubara-naiko, Mt. Hira in Oomi; Mizoroga-ike, Takaraga-ike in Yamashiro. **Shikoku**: Yamada in Tosa; Shiramizu-pass near Matsuyama in Iyo. **Kiushiu**: Miyazaki in Hiuga; Ahira in Ôsumi; Lake Unagi, Nakahama of Lake Ikeda in Satsuma. (Pl. VI. fig. 1, 7)

Distr. Japan, Siberia, Manchuria, China, Sumatra, Ceylon, Europe, N. America, S. Africa, Madagascar, Australia.

Closterium Kützingii Bréb. in Roy & Bisset Journ. Bot. **24**, 241, 1886; West Monogr. Brit. Desm. **1**, 186, 1904; Okada Imp. Fish. Inst. **30**, 146, 1934; Krieger Krypt. Fl. XIII, **1**, 351, 1935; Hirano Act. Phytotax. Geobot. **11**, 292, 1942.

Cellulae mediocres, circiter 18 longiores quam latiores, leviter curvatae, corpus cellularum non curvatum, fusiforme, marginibus lateralibus aequaliter convexis; in extrema parte breves excrescentiae curvatae, paralleliae, apicibus obtuso-rotundatis et leviter dilatatis; membrana achroa vel lutea, striata, striis ca. 11 visis in 10μ, saepe spiraliter dispositis et evanescentibus versus excrescentias; pyrenoidibus 3 in unaquaque semicellula. Long. 320–512μ, Lat. 15–22μ.

Hab. **Hokkaido**: Onne-numa in Nemuro; Wakkanai in Kitami. **Hondo**: Komozuchi in Mutsu; Megata, Moritake-ôtsutsumi in Ugo; Kobuchi-numa, Kesho-numa in Rikuzen; Hakuryu-ko in Uzen; Akaiyachi in Iwashiro; Kanazuka-mura in Echigo; Ozegahara, Oze-numa in Kôzuke; Goda-numa in Shimofusa; Mohara in Kamifusa; Sanpôji-ike in Musashi; Daimon-pass, Mt. Sanpogamine, Karuisawa in Shinano; Ô-numa, Takashihara in Mikawa; Tanuki-numa in Suruga; Kanashôzu in Ise; Shinohara-ike, Nukigawa, Mt. Hira in Oomi; Mizoroga-ike in Yamashiro; Ikejiri-ike in Tanba. **Shikoku**: Shiramizu-pass near Matsuyama in Iyo; Yamauchi-mura in Sanuki. (Pl. VIII. fig. 8)

Distr. Japan, Manchuria, Siberia, S. China, Malay, Thailand, India, Ceylon, Europe, Faroes, Greenland, N. & S. America, Africa, Australia, New Zealand, S. Africa.

Closterium rostratum EHRENB. in RALFS Brit. Desm. 175, 1848; ROY & BISSET Journ. Bot. 24, 241, 1886; WEST Monogr. Brit. Desm. 1, 183, 1904; OKADA Imp. Fish. Inst. 30, 148, 1934; KRIEGER Krypt. Fl. XIII, 1, 354, 1935; HIRANO Act. Phytotax. Geobot. 11, 299, 1942.

Cellulae mediocres, circiter 11 longiores quam latiores, leviter curvatae, lateribus internis in medio convexioribus quam externi, cellulis gradatim attenuatis polos versus, polis obtusis et cum poris terminalibus; membrana luteo-fuscescente, delicatissime striata, striis 11–12 in 10μ; chromatophorus cum 3–4 pyrenoidibus in serie unica in unaquaque semicellula. Long. 320–400μ, Lat. 29–33μ.

Hab. **Hokkaido**: Okineppe, Onne-numa in Nemuro; Junsai-aka-numa in Oshima. **Hondo**: Ôishita, Kaibai-ike in Uzen: Ozegahara in Kôzuke; Senjôgahara in Shimotsuke; Togakushi, Karuisawa in Shinano; Nukigawa in Oomi. **Shikoku**: Morimatsu in Iyo. (Pl. VI. fig. 2, 3)

Distr. Japan, N. Kuriles, Manchuria, Siberia, Burma, Java, Europe, Faroes, Iceland, Greenland, N. & S. America, E. Africa.

Closterium Ralfsii BRÉB. var. **gracilius** (MASKELL) KRIEGER in Krypt. Fl. XIII, 1, 346, 1935; HIRANO Act. Phototax. Geobot. 11, 229, 1942.

Cellulae parvae, graciliores, diametro circiter 17 longiores; membrana luteo-pallida, striata, striis 8–9 visis in 10μ. Long. 240μ, Lat. 14μ.

Hab. **Hondo**: Oze in Kôzuke; Tashiro-ike of Kamikôchi in Shinano. (Pl. VI. fig. 12)

Distr. Japan, Korea, Burma, Germany, Australia.

var. **hybridum** RABENH. in Flor. Europ. Alg. III, 135, 1868; WEST Monogr. Brit. Desm. 1, 183, 1904; FUJISAWA Journ. Jap. Bot. 10, 442, 1934; OKADA Imp. Fish. Inst. 30, 147, 1934; KRIEGER Krypt. Fl. XIII, 1, 347, 1935. —*Closterium decorum* BRÉB. in WEST Monogr. Brit. Desm. 1, 184, 1904.

Cellulae longiores et graciliores quam in forma typica, circiter 13–15 longiores quam latiores, medio cellularum leviter inflato et pyrenoidibus multis. Long. 320–523μ, Lat. 29–36μ.

Hab. **Hondo**: Ô-numa of Mt. Hachimantai in Rikuchû; Akaiyachi, Nogiwano-kwannon-ike in Iwashiro; Umaushi-numa in Iwaki; Kamikôchi, Inago in Shinano; Tanuki-numa in Suruga; Kotsutsumi-nishi-ike in Mikawa; Ishigaki-ike, Jôdo-ike in Ise; Fuse-ike, Nukigawa in Oomi; Takaraga-ike in Yamashiro. **Shikoku**: Sanri-mura, Yamada in Tosa. **Kiushiu**: Bôgatsuru of Mt. Kûju in Bungo; Yabakei in Bunzen; Kôgamuta of Aso in Higo; Ahira in Ôsumi. (Pl. VI. fig. 13)

Distr. Japan, N. Kuriles, Manchuria, Siberia, Malay, Burma, Thailand, Ceylon, Sumatra, Europe, Greenland, N. & S. America, Australia, New Zealand, Africa.

var. **novae-angliae** (CUSHMAN) KRIEGER in Krypt. Fl. XIII, 1, 348, 1935.

Cellulae angustae et graciles, circiter 28–31 longiores, leviter inflatae in medio. Long. 631–816μ, Lat. 22.4–25.8μ.

Hab. **Hondo**: Kotsutsumi-nishi-ike in Mikawa. (New to Asia) (Pl. VI. fig. 11) Distr. N. America.

Closterium venus KÜTZ. var. **incurvum** (BRÉB.) KRIEGER in Krypt. Fl. XIII, 273, 1935. —*Closterium incurvum* BRÉB in WEST Monogr. Brit. Desm. 1, 136, 1904; FUJISAWA Journ. Jap. Bot. **10**, 442, 1934.

Cellulae parviores et latiores quam in forma typica, circiter 6–7 longiores quam latiores. Long. 50–73μ, Lat. 8.4–11μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Chôbushi-numa in Nemuro; Nikuru-numa in Kitami; Toyokoro in Tokachi; Yasuushi in Teshio; Moseushi, Nakano and Moere-numa in Sapporo, Horomui in Ishikari; Junsai-aka-numa in Oshima. **Hondo**: Bora-numa, Komozuchi in Mutsu; Aka-numa, Moritake-ôtsutsumi, Kotomo-numa, Megata, Nishi-numa, Kariwano in Ugo; Chûkawa-ike in Uzen; Izu-numa, Kesho-numa, Kobuchi-numa in Rikuzen; Nanko, Ojiroi, Umaushi-numa in Iwaki; Kôriyama in Iwashiro; Gôno-ike, Kitaura in Hitachi; Goda-numa, Higusa-numa in Shimofusa; Onjaga-ike, Hakkaku-ike, Mohara in Kamifusa; Kagami-ike of Matsunoyama in Echigo; Kanori-ike, Ashinota-ike, Kizaki, Tashiro-ike of Kamikôchi, Karuisawa in Shinano; Takashihara, Suhara-ike, Ô-numa in Mikawa: Tamaru, Jôdo-ike in Ise; Matsubaranai-ko, Nukigawa, Fuse-ike in Oomi; Takaraga-ike, Shakuhachi-ike in Yamashiro: Ikejiri-ike in Tanba. **Shikoku**: Yamauchi-mura in Sanuki; Dôgo in Iyo. **Kiushiu**: Kôga-muta of Aso in Higo; Miyazaki, Mt. Ôhata of Kirishima in Hiuga; Ahira in Ôsumi; Fukiage-nakahara-ike, Lake Ikeda in Satsuma. (Pl. VI. fig. 4)

Distr. Japan, Siberia, Manchuria, Burma, Ceylon, Europe, N. America, Brazil, E. Africa.

Closterium parvulum NÄG. in Gatt. einz. Alg. 106, 1849; ROY & BISSET Journ. Bot. **24**, 241, 1886; WEST Monogr. Brit. Desm. **1**, 133, 1904; OKADA Imp. Fish. Inst. **30**, 147, 1934; FUJISAWA Journ. Jap. Bot. **10**, 442, 1934; KRIEGER Krypt. Fl. XIII, **1**, 275, 1935; HIRANO Act Phytotax. Geobot. **11**, 298, 1942.

Cellulae parvae, circiter 8 longiores quam latiores, valde curvatae, gradatim attenuatae ad polos, polis acute-rotundatis, lateribus internis concavis vel rectis in medio, raro leviter tumidis; membrana glabra, incolora, raro luteo-fuscescente, pyrenoidibus 3–4 in serie unica in unaquaque semicellula. Long. 84–131μ, Lat. 8.4–15μ.

Hab. **Hokkaido**: Okineppe in Nemuro; Nikuru-numa in Kitami; Akanjunsai-numa in Kushiro; Junsai-aka-numa in Oshima. **Hondo**: Nagatai near Mt. Iwaki in Mutsu; Hoso-numa, Nishi-numa, Hirumo-numa, Moritake-ôtsutsumi, Aka-numa, Mt. Komagatake in Ugo; Eboshi-numa in Uzen; Umaushi-numa in Iwaki; Hôzawa-ike in Iwashiro; Ozegahara, Oze-numa in Kôzuke, Goda-numa in Shimofusa; Mohara in Kamifusa; Sanpôji-ike in Musashi; Mt. Myôko, Kôridono-ike in Echigo; Daimon-pass, Ôhanami-ike, Kamikochi, Daizahôshi-ike, Ôniu-ike of Mt. Norikura, Inago in Shinano; Kotsutsumi-nishi-ike, Ô-numa in Mikawa; Lake Biwa, Nukigawa in Oomi;

Mizoroga-ike, Ariga-ike in Yamashiro. **Kiushiu**: Yabakei in Bunzen; Nakahama of Lake Ikeda in Satsuma. (Pl. IV. fig. 13)

Distr. Japan, Kuriles, Manchuria, Siberia, China, Thailand, Java, Sumatra, Ceylon, Asia Minor, Europe, Nova Zembla, Greenland, N. America, Australia, Patagonia, Africa.

var. **angustum** W. & G. S. WEST in Journ. Bot. 38, 290, 1900; Monogr. Brit. Desm. 1, 134, 1904; SKVORTZOW Phillip. Journ. Sci. **49**, 149, 1932; KRIEGER Krypt. Fl. XIII, **1**, 277, 1935.

Cellulae angustiores, circiter 11–12 longiores quam latiores, modice curvatae et curvae variabiles, nonnumquam leves et interdum fere semicirculares. Long. 98–123μ, Lat. 8.4–11μ.

Hab. **Hondo**: Ushiku-numa in Hitachi; Matsubara-naiko, Fuse-ike, Shinohara-ike in Oomi. (New to Japan) (Pl. IV. fig. 14)

Distr. Korea, China, Java, Sumatra, Europe, N. & S. America, E. Africa.

Closterium tumidulum GAY in SKUJA Act. Horti Bot. Univ. Latv. **3**, 138, 1928; KRIEGER Krypt. Fl. XIII, **1**, 279, 1935.

Cellulae parvae, diametro circiter 6-duplo longiores, valide curvatae, gradatim attenuatae ad polos, polis acute rotundis, lateribus internis leviter tumidis in medio; membrana incolora, glabra, cum 3 pyrenoidibus in unaquaque semicellula. Long. 128–130μ, Lat. 21μ.

Hab. **Shikoku**: Yodo-mura in Iyo. (New to Japan) (Pl. III. fig. 1)

Distr. India, Sumatra, Europe, U. S. A., Bolivia, Patagonia.

Closterium calosporum WITTR. var. **maius** W. & G. S. WEST in SKUJA Act. Horti Bot. Univ. Latv. **3**, 130, 1928; KRIEGER Krypt. Fl. XIII, **1**, 293, 1935.

Cellulae maiores, diametro circiter 10 longiores, pyrenoidibus 4 in unaquaque semicellula. Long. 176μ, Lat. 16.8μ.

Hab. **Shikoku**: Morimatsu in Iyo. (New to Asia)

Distr. Europe, S. Africa.

var. **brasiliense** BÖRG. in DEFLANDRE Bull. Soc. Bot. Fr. **73**, 991, 1926; KRIEGER Krypt. Fl. XIII, **1**, 294, 1935.

Cellulae parvae et angustae, circiter 7–10 longiores quam latiores. Long. 126–150μ, Lat. 8μ. Forma typica non observata.

Hab. **Hokkaido**: Tôro-ko in Kushiro; Horomui in Ishikari; Ko-numa in Oshima. **Hondo**: Akaiyachi in Iwashiro; Goda-numa in Shimofusa; Inago in Shinano; Tanuki-numa in Suruga; Kotsutsumi-nishi-ike in Mikawa; Jôdo-ike in Ise; Nukigawa in Oomi; Ariga-ike in Yamashiro. **Kiushiu**: Imuta-ike in Satsuma. (Pl. IV. fig. 11)

Distr. Japan, Europe, N. America, Brazil.

Closterium dianae EHRENB. in RALFS Brit. Desm. 168, 1848; WEST Monogr. Brit. Desm. 1, 130, 1904; HIGASHI List Jap. Freshw. Alg. 270, 1916; OKADA Imp. Fish. Inst. **30**, 144, 1934;

KRIEGER Krypt. Fl. XIII, 1, 294, 1935.

Cellulae mediocres, diametro 10–12 longiores, valide curvatae, gradatim attenuatae ad polos, polis obtuso-rotundatis vel acuto-rotundatis, lateribus internis concavis sed rectis vel levissime tumidis in medio, apicibus cum distinctis poris extremis; membrana achroa et lutea vel rufescente, pyrenoidibus 5–7 in unaquaque semicellula. Long. 176–323μ, Lat. 20–28μ.

Hab. **Hokkaido:** Okineppe in Nemuro; Kiritappu, Akan-junsai-numa, Tôro-ko in Kushiro; Nikuru-numa in Kitami; Toyokoro in Tokachi; Yasuushi in Teshio; Tomakomai in Iburi; Horomui, Moere-numa, Moseushi in Ishikari; Ko-numa, Junsai-numa in Oshima. **Hondo:** Kurobo-numa, Rokuzawa-tameike, Kyûtai in Mutsu; Kotomo-numa, Kariwano, Koke-numa, Nishi-numa, Megata in Ugo; Ô-numa of Mt. Hachimantai in Rikuchû; Ôishita, Chûkawa-ike in Uzen; Kesho-numa, Naga-numa, Izu-numa in Rikuzen; Kôriyama, Kagami-ishi-mura, Akaiyachi in Iwashiro; Nanko, Umaushi-numa in Iwaki; Mt. Akagi, Ômine-numa in Kôzuke; Senjôgahara in Shimotsuke; Onjaga-ike in Kamifusa; Higusa-numa, Goda-numa in Shimofusa; Kitaura in Hitachi; Daimon-pass, Karuisawa, Lake Nakatsuna, Kizaki in Shinano; Tanuki-numa in Suruga; Takashihara in Mikawa; Biwa-ike in Owari; Tamaru, Toba, Jôdo-ike, Kanashôzu in Ise; Shinohara-ike, Fuse-ike, Nukigawa in Oomi; Mizoroga-ike, Ariga-ike in Yamashiro. **Shikoku:** Yamada in Tosa; Yamauchi-mura in Sanuki; Dôgo, Shiramizu-pass near Matsuyama in Iyo. **Kiushiu:** Yabakei in Bunzen; Ahira in Ôsumi; Fukiage-nakahara-ike in Satsuma. (Pl. III. fig. 3, 4; Pl. IV. fig. 2)

Distr. Japan, N. Kuriles, Siberia, China, Burma, Thailand, Ceylon, Java, Europe, Nova Zembla, Spitzbergen, Greenland, N. & S. America, Hawaii, Australia, New Zealand, Africa.

Closterium dianae is a common species in eutrophic water, especially ponds, marshes or even in rice-field and is widely distributed in Japan, but is not found on upland water and *sphagnum* moor. The size of cell is variable in localities and in ponds and marshes near Kyoto are found two groups of this species, one is of a small size of Long. 176–192μ, Br. 17–20μ, and the other is of a large size of Long. 288–323μ, Br. 22.4–24.5μ.

var. **minus** (WILLE) SCHRÖDER in Krieger Krypt. Fl. XIII, 1, 296, 1935.

Cellulae parviores quam in forma typica, Long. 150μ, Lat. 15μ parviores. Long. 140μ, Lat. 15μ.

Hab. **Hondo:** Saigo-mura in Uzen; Kanazuka-mura in Echigo; Takaraga-ike in Yamashiro. **Shikoku:** Yamada in Tosa. **Kiushiu:** Yabakei in Bunzen; Imuta-ike, Nakahama of Lake Ikeda in Satsuma. (Pl. IV. fig. 3)

Distr. Japan, Europe, E. Africa.

var. **pseudodianae** (ROY) KRIEGER in Krypt. Fl. XIII, 1, 297, 1935; HIRANO Act. Phytotax. Geobot. 11, 289, 1942. —*Closterium pseudodianae* ROY in WEST Monogr. Brit. Desm. 1, 132,

1904.

Cellulae levissime elongatae et tenues, diametro 16–23 longiores, lateribus internis non tumidis in medio; membrana glabra, achroa, vel lutea, pyrenoidibus 7–9 in unaquaque semicellula. Long. 208–304μ, Lat. 12.6–16.8μ.

Hab. **Hokkaido**: Chôbushi-numa in Nemuro; Shiraoi-poruto-numa in Iburi. **Hondo**: Komozuchi in Mutsu; Hirumo-numa in Ugo; Saigo-mura in Uzen; Ojiroi in Iwaki; Oze-numa in Kôzuke; Kagami-ike of Matsunoyama in Echigo; Ôhanami-ike in Shinano; Matsubara-naiko in Oomi; Shakuhachi-ike in Yamashiro. **Kiushiu**: Fukiage-nakahara-ike, Kagami-ike, Nakahama of Lake Ikeda in Satsuma. (Pl. IV. fig. 1)

Distr. Japan, Ceylon, Europe, N. America, Brazil, Australia, E. Africa, Madagascar.

Closterium pusillum HANTZSCH var. **minus** ALLORGE in KRIEGER Krypt. Fl. XIII, 1, 280, 1935.

Cellulae parviores et breviores quam in forma typica, diametro circiter 4 longiores, pyrenoidibus singulis in unaquaque semicellula. Long. 22.4μ, Lat. 4.8μ.

Hab. **Hondo**: Kaminota on Mt. Kazafuki in Shinano. (New to Asia) (Pl. VIII. fig. 10)

Distr. Letland, Spain, Brazil.

Closterium moniliferum (BORY) EHRENB. in RALFS Brit. Desm. 166, 1848; ROY & BISSET Journ. Bot. 24, 241, 1886; West Monogr. Brit. Desm. 1, 142, 1904; KRIEGER Krypt. Fl. XIII, 1, 289, 1935; HIRANO Act. Phytotax. Geobot. 11, 296, 1942.

Cellulae mediocres, robustae, circiter 5–6 longiores quam latiores, modice curvatae, uniformiter attenuatae ad polos, polis obtuso-rotundis, lateribus internis rectis vel leviter tumidis in medio; membrana glabra, achroa; chromatophorus cum 5–6 pyrenoidibus in serie unica in unaquaque semicellula. Long. 272–384μ, Lat. 36–60μ.

Hab. **Hokkaido**: Okineppe, Onne-numa, Chôbushi-numa in Nemuro; Tokotan in Kushiro; Moere-numa of Sapporo in Ishikari; Shiraoi-poruto-numa in Iburi. **Hondo**: Kurobo-numa, Kyûtai in Mutsu; Ogata, Kawashiri, Kariwano in Ugo; Hakuryu-ko, Kaibai-ike, Saigo-mura in Uzen; Kesho-numa, Izu-numa, Kobuchi-numa in Rikuzen; Akaiyachi, Nogiwano-kwannon-ike, Kagami-ishi-mura in Iwashiro; Ozegahara, Oze-numa in Kôzuke; Senjôgahara in Shimotsuke; Kitaura in Hitachi; Goda-numa in Shimofusa; Onjaga-ike, Hakkaku-ike in Kamifusa; Kôridonono-ike, Kagami-ike of Matsunoyama in Echigo; Nata-ike of Otari, Nenbutsu-ike of Togakushi, Daizahôshi-ike, Ashinota-ike, Kamikôchi in Shinano; Takashihara, Ô-numa in Mikawa; Matsubara-naiko, Fuse-ike, Nukigawa, Mt. Hira in Oomi; Tamaru in Ise; Ariga-ike, Shakuhachi-ike, Hirosawano-ike in Yamashiro. **Shikoku**: Misato-mura in Tosa; Morimatsu, Dôgo in Iyo. **Kiushiu**: Yabakei in Bunzen; Bôgatsuru of Mt. Kujû in Bungo; Kurino, Ahira in Ôsumi; Kôgamuta of Aso in Higo; Ko-ike of Kirishima in Hiuga. (Pl. III. fig. 6)

Distr. Japan, Manchuria, Siberia, Kamtchatka, China, Malay, Tibet, Borneo, Java, Ceylon, Europe, Iceland, N. & S. America, New Zealand, Africa.

var. **concavum** KLEBS in KRIEGER Krypt. Fl. XIII, 1, 201, 1935.

Cellulae rarius curviores quam in forma typica, lateribus internis concavis vel prope rectis in medio. Long. 300–344μ, Lat. 39–45μ.

Hab. **Hokkaido**: Onne-numa in Nemuro; Yasuushi in Teshio. **Hondo**: Izu-numa in Rikuzen; Takashihara in Mikawa. **Shikoku**: Yamauchi-mura in Sanuki. (New to Asia) (Pl. III. fig. 7)

Distr. Germany, Sweden, Poland, Orkney.

Closterium Leibleinii KÜTZ. in RALFS Brit. Desm. 167, 1848; ROY & BISSET Journ. Bot. **24**, 241, 1886; WEST Monogr. Brit. Desm. 1, 141, 1904; OKADA Bull. Biogeogr. Soc. Jap. **3**, 44, 1932; KRIEGER Krypt. Fl. XIII, 1, 283, 1935.

Cellulae submediocres, circiter 6 longiores, modice curvatae, gradatim attenuatae et curvatae polos versus, polis obtuso-rotundatis, nonnumquam plus curvatis infra apicem, medio cellularum distincte tumido; membrana glabra, achroa, vel raro lutea; chromatophorus cum pyrenoidibus 4–7 in serie unica in unaquaque semicellula. Long. 140–256μ, Lat. 33–34μ.

Hab. **Hokkaido**: Yasuushi in Teshio; Moseushi, Horomui, Nakano of Sapporo in Ishikari. **Hondo**: Futatsuyagata, Aka-numa in Ugo; Inago of Kitamaki-mura in Shinano; Takaraga-ike, Hirosawano-ike in Yamashiro. **Shikoku**: Yodo-mura, Shiramizu-pass near Matsuyama in Iyo. (Pl. IV. fig. 4, 12)

Distr. Japan, Manchuria, Siberia, Ceylon, Europe, Iceland, Nova Zembla, Greenland, N. & S. America, Australia, Samoa, New Caledonia, Africa, Madagascar.

Closterium Ehrenbergii MENEGH. in RALFS Brit. Desm. 166, 1848; ROY & BISSET Journ. Bot. **24**, 240, 1886; WEST Monogr. Brit. Desm. 1, 143, 1904; FUJISAWA Journ. Jap. Bot. **10**, 442, 1934; KRIEGER Krypt. Fl. XIII, 1, 285, 1935.

Cellulae magnae, circiter 5–6 longiores, modice curvatae, gradatim attenuatae polos versus, polis obtuso-rotundatis, lateribus externis valide convexis, internis fere rectis vel leviter tumidis in medio; membrana glabra, achroa, sine zona mediana; laminae chromatophori circ. 4–7 observatae, pyrenoidibus numerosis irregulariter dispositis. Long. 384–416μ, Lat. 64–84μ.

Hab. **Hokkaido**: Horomui in Ishikari. **Hondo**: Kotomo-numa, Ogata, Kawashiri in Ugo; Ôishita, Saigo-mura in Uzen; Izu-numa, Kobuchi-numa in Rikuzen; Akaiyachi in Iwashiro; Kôridonono-ike in Echigo; Nenbutsu-ike of Togakushi, Kamikôchi, Inago in Shinano; Ô-numa in Mikawa; Tamaru in Ise; Matsubara-naiko, Fuse-ike in Oomi; Ikejiri-ike in Tanba. **Kiushiu**: Ahira in Ôsumi. (Pl. III. fig. 11)

Distr. Japan, Sakhalin, Manchuria, China, Thailand, India, Borneo, Europe, N. & S. America, New Caledonia, Samoa, Australia, New Zealand, Africa, Patagonia.

var. **atumidum** GRÖNBL. in KRIEGER Krypt. Fl. XIII, 1, 287, 1935.

Cellulae leviter variabiliter curvatae, non tumidae in medio, lateribus internis

numquam concavis. Long. 416–508μ, Lat. 60–69μ.

Hab. **Hondo:** Aka-numa in Ugo; Izu-numa, Kobuchi-numa, Naga-numa in Rikuzen; Kitaura in Hitachi; Onjaga-ike in Kamifusa; Nukigawa in Oomi. **Shikoku:** Dôgo, Yodo-mura in Iyo. (New to Asia) (Pl. III. fig. 9, 10)

Distr. Finland.

Closterium Wallichii TURNER in KRIEGER Krypt. Fl. XIII, 1, 320, 1935.

Cellulae mediocres, circiter 11–12 plo longiores quam latiores, modice curvatae, non tumidae in medio, gradatim attenuatae ad polos, polis acuto-rotundis; membrana incolora vel lutea, delicatissime striata et vix visibilis alte ornata. Long. 400–464μ, Lat. 39–45μ.

Hab. **Hondo:** Nogiwano-kwannon-ike in Iwashiro. **Kiushiu:** Nakahama of Lake Ikeda in Satsuma. (New to Japan) (Pl. III. fig. 8)

Distr. India, Java.

Our form of *Closterium Wallichii* does not exactly coincide with the Turner's figure by the longer and more slender cell. The cell wall is colourless and smooth but as the striae of *Cl. Wallichii* is delicate and fine, it is not visible unless the individual is fully old and brownish in colour.

Closterium abruptum W. WEST in WEST Monogr. Brit. Desm. 1, 158, 1904; KRIEGER Krypt. Fl. XIII, 1, 306, 1935.

Cellulae submediocres, circiter 14–17 longiores quam latiores, leviter curvatae, sensim et gradatim attenuatae polos versus, polis late et truncato-rotundatis, lateribus internis leviter concavis, non tumidis; membrana glabra, cum zona mediana, luteo-fuscescente; chromatophorus cum pyrenoidibus 4–8 in serie unica in unaquaque semicellula. Long. 193–310μ, Lat. 11–22μ.

Hab. **Hondo:** Kotsutsumi in Mutsu; Kobuchi-numa in Rikuzen; Kôriyama in Iwashiro; Kashima-cho in Iwaki; Ko-numa of Mt. Akagi in Kôzuke; Tarobei-daira, Kurobegoro-daira in Etchû; Tashiro-ike of Kamikôchi in Shinano; Takashihara in Mikawa; Kanashôzu in Ise; Ko-ike in Yamashiro. **Shikoku:** Yamada in Tosa. (New to Japan) (Pl. IV. fig. 7)

Distr. India, Manchuria, Europe, U. S. A., S. America.

Closterium macilentum BRÉB. in ROY & BISSET Journ. Bot. 24, 240, 1886; WEST Monogr. Brit. Desm. 1, 118, 1904; KRIEGER Krypt. Fl. XIII, 1, 312, 1935.

Cellulae submagnae, elongatae, diametro 25–40 longiores, modice curvatae, levissime et gradatim attenuatae, medio cellularum recto, fere parallelo, non tumido, sed curvato polos versus, polis truncato-rotundatis et cum prominente poro; membrana glabra, luteo-fuscescente; chromatophorus cum 9–15 pyrenoidibus in serie unica in unaquaque semicellula. Long. 432–678μ, Lat. 14–21μ.

Hab. **Hondo:** Chûkawa-ike, Ôishita in Uzen; Izu-numa, Kobuchi-numa in

Rikuzen; Kizaki in Shinano; Kotsutsumi-nishi-ike in Mikawa; Kanashôzu in Ise; Matsubara-naiko in Oomi; Takaraga-ike in Yamashiro. (Pl. V. fig. 4)

Distr. Japan, Korea, Manchuria, China, India, Europe, N. & S. America, Australia.

var. **japonicum** (SURINGAR) GRÖNBL. in KRIEGER Krypt. Fl XIII, 1, 314, 1935.

Cellulae leviter curvatae, diametro circiter 12 longiores quam latiores, lateribus internis concavis; membrana striata, striis subtilis et circa 5 in 10μ. Long. 447–578μ, Lat. 32–34μ.

Hab. **Hondo**: Benze-numa, Kyutai in Mutsu; Futatsuyagata, Megata in Ugo; Kesho-numa, Kobuchi-numa in Rikuzen; Hakuryu-ko in Uzen; Kôridonono-ike in Echigo; Togakushi in Shinano. **Shikoku**: Yamada, Nashiura of Misato-mura in Tosa. (Pl. V. fig.2, 3)

Distr. Japan.

I have never met with the typical form corresponding to the SURRINGAR's original figure and his brief description. His dimension is Length 400–600μ, Breadth 23–25μ, however in our form the breadth of cell is always 32–34μ and is never below 25μ.

Closterium Braunii REINSCH in WEST Trans. Linn. Soc. Bot. 5, 236, 1896; GRÖNBLAD Act. Soc. Faun. Flor. Fenn. 47, 14, 1920; HOMFELD Pflanzenf. 12, 17, 1929; KRIEGER Krypt. Fl. XIII, 1, 343, 1935.

Cellulae modice magnae, elongatae, leviter curvatae, non tumidae in medio, circiter 21–23 longiores quam latiores, levissime gradatim attenuatae ad apices, apicibus conicis et truncato-rotundis vel subito attenuatis prope apicem; membrana fuscescente et cum sutura mediana, punctato-striata, striis in serie duobus punctorum consistis et irregulariter dispositis ad apicem, membrana fine punctata inter strias. Long. 736–832μ, Lat. 35μ.

Hab. **Hokkaido**: Toyokoro-konuma in Tokachi. (New to Asia) (Pl. VIII. fig. 2, 9)

Distr. Germany, Finland, Poland. U. S. A., Brazil.

Closterium Ulna FOCKE in WEST Monogr. Brit. Desm. 1, 127, 1904; KRIEGER Krypt. Fl. XIII, 1, 341, 1935; HIRANO Act. Phytotox. Geobot. 11, 302, 1942.

Cellulae mediocres, diametro circiter 15–19 longiores, leviter curvatae, non tumidae, valde gradatim attenuatae ad polos, polis truncato-rotundatis, lateribus internis leviter concavis, lateribus utrisque aequaliter curvatis et subparallelis; membrana luteo-pallida vel fuscescente, striata, striis circiter 10–11 visis in 10μ; chromatophorus cum pyrenoidibus 6–7 in unaquaque semicellula. Long. 192–462μ, Lat. 11–22μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Horomui in Ishikari. **Hondo**: Mt. Hakkoda, Benze-numa in Mutsu; Ôyachi of Mt. Hachimantai in Rikuchû; Hoso-numa, Megata, Hirumo-numa in Ugo; Mt. Azuma, Akaiyachi in Iwashiro; Oze in Kôzuke; Mt. Naeba in Echigo; Mt. Tateyama in Etchû; Tengunohara of Mt. Shiro-uma in Shinano; Takashihara in Mikawa; Jôdo-ike, Tamaru in Ise. **Kiushiu**:

Hirabaru of Yabakei in Bunzen. (Pl. VIII. fig. 13)

Distr. Japan, Siberia, China, India, Java, Europe, U. S. A., New Zealand.

Closterium juncidum RALFS in Brit. Desm. 172, 1848; WEST Monogr. Brit. Desm. 1, 128, 1904: FUJISAWA Journ. Jap. Bot. 10, 442, 1934; KRIEGER Krypt. Fl. XIII, 1, 333, 1935.

Cellulae parvae, diametro circiter 22–23 duplo longiores quam latiores, leviter curvatae, leviter attenuatae ad polos, polis oblique vel obtuse truncato-rotundis; membrana incolora et striata, striis circa 5–7 trans cellulam, cum zona mediana; chromatophorus cum 4–6 pyrenoidibus in unaquaque semicellula. Long. 224–320μ, Lat. 9.8–12μ.

Hab. **Hokkaido:** Kiritappu in Kushiro. **Hondo:** Akaiyachi in Iwashiro; Ina in Shinano. (FUJISAWA) (Pl. VIII. fig. 16)

Distr. Japan, Manchuria, Burma, India, Java, Europe, Greenland, U. S. A., Colombia, Australia, New Zealand, E. Africa.

Closterium intermedium RALFS in Brit. Desm. 171, 1848; WEST Monogr. Brit. Desm. 1, 125, 1905; KRIEGER Krypt. Fl. XIII, 1, 335, 1935.

Cellulae mediocres, circiter 12–14 longiores quam latiores, modice curvatae, gradatim attenuatae ad polos, polis truncato-rotundis, lateribus internis leviter concavis, non tumidis in medio; membrana lutea, striata, striis distinctis et circa 10 visis in 10μ, zona mediana observata; chromatophorus cum pyrenoidibus 5–7 in serie centrali in unaquaque semicellula. Long. 200–330μ, Lat. 17–22.4μ.

Hab. **Hokkaido:** Okineppe, Chôbushi-numa in Nemuro; Tôro-ko in Kushiro; Toyokoro in Tokachi; Horomui, Moere-numa in Ishikari. **Hondo:** Mt. Iwaki, Benze-numa, Kotsutsumi in Mutsu; Koke-numa, Hirumo-numa, Moritake-ôtsutsumi, Megata in Ugo; Hakuryu-ko, Ôishita, Chûkawa-ike, Mt. Gassan in Uzen; Akaiyachi, Mt. Azuma in Iwashiro; Umaushi-numa in Iwaki; Ômine-numa in Kôzuke, Goda-numa in Shimofusa; Mt. Tateyama in Etchû; Mt. Kirigamine, Mt. Sanpôgamine, Tengunohara, Happo-ridge, Inago in Shinano; Tanuki-numa in Suruga; Kotsutsumi-nishi-ike, Ô-numa in Mikawa; Jôdo-ike, Kanashôzu, Ishigaki-ike in Ise; Mt. Hira, Shinohara-ike in Oomi; Mizoroga-ike, Shakuhachi-ike, Sawano-ike in Yamashiro. **Shikoku:** Matsuyama in Iyo; Yamada in Tosa. **Kiushiu:** Ahira in Ôsumi; Imuta-ike in Satsuma. (Pl. VI. fig. 6, Pl. VIII. fig. 14, 15)

Distr. Japan, Sakhalin, Korea, Manchuria, Siberia, Burma, India, Ceylon, Java, Europe, Greenland, N. & S. America, Australia.

Closterium striolatum EHRENB. in RALFS Brit. Desm. 170, 1848; ROY & BISSET Journ. Bot. 24, 240, 1886; WEST Monogr. Brit. Desm. 1, 122, 1904; KRIEGER Krypt. Fl. XIII, 1, 337, 1935; HIRANO Act. Phytotax. Geobot. 11, 301, 1942.

Cellulae mediocres, 8–9 longiores quam latiores, modice curvatae, non tumidae in medio, gradatim attenuatae ad polos, polis late et truncato-rotundis, lateribus internis concavis vel interdum rectis; membrana luteo-fuscescente, striata, striis circa

20 visis; cum distincte zona mediana; chromatophorus cum pyrenoidibus 5–6 in unaquaque semicellula. Long. 210–493μ, Lat. 24–45μ.

Hab. **Hokkaido**: Onne-numa in Nemuro; Kiritappu, Tokotan in Kushiro; Nikuru-numa, Wakkanai in Kitami; Horomui, Moseushi in Ishikari. **Hondo**: Mt. Hakkoda, Hachiman-numa of Mt. Hachimantai in Mutsu; Ogata, Mt. Komagatake in Ugo; Mt. Kurikoma in Rikuchû; Hijiori-naga-numa, Mt. Sugigamine of Zawo, Ôishita, Naga-numa of Mazawa, Saigo-mura in Uzen; Izu-numa in Rikuzen; Ojiroi in Iwaki; Mt. Azuma, Akaiyachi, Mt. Bandai in Iwashiro; Kanazuka-mura, Mt. Myôko, Mt. Naeba, Kagami-ike of Matsunoyama in Echigo; Ozegahara in Kôzuke; Senjôgahara in Shimotsuke; Goda-numa in Shimofusa; Sanpôji-ike in Musashi; Kamikôchi(YONEDA), Shigakôgen, Daimon-pass, Mt. Kirigamine, Happô-ridge, Kaminotanbo of Shirouma, Ôhanami-ike, Karuisawa, Ashinota-ike, Lake Kizaki in Shinano; Mt. Hichimenzan in Kai; Takashihara in Mikawa; Tamaru in Ise; Nukigawa, Mt. Hira in Oomi. **Shikoku**: Yamada in Tosa; Matsuyama in Iyo. **Kiushiu**: Yabakei in Bunzen. (Pl. VII. fig. 10–12)

Distr. Japan, Kuriles, Manchuria, Siberia, China, Malay, Burma, India, Ceylon, Europe, Spitzbergen, Greenland, Nova Zembla, U. S. A., Brazil, New Zealand, E. Africa.

var. **subpunctatum** HIRANO in Act. Phytotax. Geobot. 12, 157, 1943.

Membrana dense punctata (non striata) sed striata valde in apice et prope apicem, rufescente valde praecipue in parte apicis. Long. 272–368μ, Lat. 31–34μ.

Hab. **Hondo**: Ozegahara in Kôzuke; Daimon-pass in Shinano; Fuse-ike, Mt. Hira in Oomi. (Pl. VIII. fig. 1)

Distr. Japan.

Closterium acerosum (SCHRANK) EHRENB. in RALFS Brit. Desm. 164, 1848; ROY & BISSET Journ. Bot. 24, 240, 1886; WEST Monogr. Brit. Desm. 1, 146, 1904; KRIEGER Krypt. Fl. XIII, 1, 314, 1935; YAMAGUCHI & HIRANO Act. Plytotax. Geobot. 15, 22, 1953.

Cellulae magnae, circiter 14 longiores quam latiores, sensim curvatae, gradatim attenuatae ad polos, polis acutis et truncatis, lateribus externis leviter convexis, internis fere rectis vel leviter convexis; membrana glabra vel delicatissime striata, achroa vel lutea; chromatophorus cum 7–15 pyrenoidibus in serie centrali in unaquaque semicellula. Long. 403–576μ, Lat. 39–84μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Horomui in Ishikari. **Hondo**: Umaushi-numa in Iwaki; Daizahôshi-ike in Shinano; Kotsutsumi-nishi-ike in Mikawa; Lake Biwa in Oomi; Hirosawano-ike, Rokujizô in Yamashiro. **Shikoku**: Dôgo in Iyo. **Kiushiu**: Lake Unagi in Satsuma. (Pl. VIII. fig. 12; Pl. IX. fig. 3)

Distr. Japan, Manchuria, China, Siberia, Thailand, India, Ceylon, Sumatra, Java, Europe, Iceland, Nova Zembla, Greenland, N. & S. America. Australia, Patagonia, New Zealand, New Caledonia.

var. **tumidum** BORGE in KRIEGER Krypt. Fl. XIII, 1, 319, 1935.

Var. lateribus internis in medio leviter tumidis, polis anguste et truncato-rotundis, diametro circiter 8–9 longioribus; membrana glabra. Long. 384μ, Lat. 42μ.

Hab. **Shikoku**: Yodo-mura in Iyo. (New to Asia) (Pl. III. fig. 12)

Distr. Sweden, Poland, Patagonia.

Closterium turgidum EHRENB. in RALFS Brit. Desm. 165, 1848; WEST Monogr. Brit. Desm. 1, 170, 1904; KRIEGER Krypt. Fl. XIII, 1, 330, 1935; HIRANO Act. Phytotax. Geobot. 11, 302, 1942.

Cellulae magnae, circiter 14 longiores quam latiores, leviter curvatae, gradatim attenuatae ad polos, polis truncato-rotundatis, lateribus internis leviter concavis, non tumidis; membrana fuscescente, striata, striis circa 11–12 visis in 10μ, et leviter recurvata juxta apicem; chromatophorus cum 8–9 pyrenoidibus in serie centrali in unaquaque semicellula. Long. 448–848μ, Lat. 45–51μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Toyokoro in Tokachi. **Hondo**: Ozegahara in Kôzuke. (Pl. V. fig. 7)

Distr. Japan, Siberia, Europe, N. & S. America, W. Africa.

var. **Borgei** (BORGE) DEFLANDRE in KRIEGER Krypt. Fl. XIII, 1, 331, 1935.

Cellulae raro magnae, diametro circiter 17 longiores quam latiores, apicibus externis cellulae leviter concavis vel rectis. Long. 724–800μ, Lat. 43–45μ.

Hab. **Hondo**: Izu-numa in Rikuzen; Tanuki-numa in Suruga. (New to Japan) (Pl. V. fig. 6)

Distr. Sumatra, France, Sweden, N. America, Brazil.

Closterium didymotocum RALFS in Brit. Desm. 168, 1848; WEST Monogr. Brit. Desm. 1, 116, 1904; KRIEGER Krypt. Fl. XIII, 1, 325, 1935.

Cellulae magnae, diametro circiter 8–9 duplo longiores, levissime curvatae, gradatim attenuatae ad polos, polis late et truncato-subconicis, lateribus internis paene rectis vel leviter concavis; membrana cum zona mediana et luteola vel fuscescente, praecipue fuscescente infra polos, irregulariter striata, inter strias delicatiesme punctata. Long. 448–492μ, Lat. 49–50μ.

Hab. **Hokkaido**: Kiritappu in Kushiro. **Hondo**: Nogiwano-kwannon-ike, Akaiyachi in Iwashiro. (Pl. V. fig. 1)

Distr. Kuriles, Siberia, India, Europe, Greenland, U. S. A., Colombia, New Zealand, Africa.

Closterium angustatum KÜTZ. in RALFS Brit. Desm. 172, 1848; WEST Monogr. Brit. Desm. 1, 119, 1904; OKADA Imp. Fish. Inst. 30, 142, 1934; KRIEGER Krypt. Fl. XIII, 1, 363, 1935; HIRANO Act. Phytotax. Geobot. 11, 286, 1942.

Cellulae mediocres, circiter 19 longiores quam latiores, leviter curvatae, non

tumidae, sensim attenuatae ad polos, polis truncato-rotundatis, lateribus externis et internis parallelis in medio, aequaliter curvatis, internis leviter concavis; membrana fuscescente, costata, costis visis 5 et in medio spiraliter dispositis, sed punctata et vanescente infra apicem; pyrenoidibus 7 in unaquaque semicellula. Long. 357–368μ, Lat. 17–19.6μ.

Hab. **Hondo:** Ozegahara in Kôzuke; Kamaga-ike of Kirigamine, Happô-ridge in Shinano. (Pl. VII. fig. 3)

Distr. Japan, N. Kuriles, Siberia, China, India, Java, Europe, U. S. A., New Foundland.

Closterium subjuncidiforme GRÖNBL. in Act. Soc. Faun. Flor. Fenn. **47**, 24, 1920; KRIEGER Krypt. Fl. XIII, **1**, 362, 1935.

Cellulae mediocres vel plus mediocres, diametro circiter 15 longiores quam latiores, modice curvatae, non tumidae in medio, gradatim attenuatae ad polos, polis rotundis, lateribus internis concavis; membrana luteo-fucescente, cum zona mediana, costata, costis 4 in 10μ; chromatophorus cum 5–7 pyrenoidibus in serie centrali in unaquaque semicellula. Long. 368–420μ, Lat. 22–24μ.

Hab. **Hondo:** Ariga-ike in Yamashiro. **Kiushiu:** Miyazaki in Hiuga. (New to Asia) (Pl. VII. fig. 4)

Distr. Germany, Finland.

The Japanese form of *Closterium subjuncidiforme* is somewhat narrower in dimension than European forms.

Closterium costatum CORDA in RALFS Brit. Desm. 170, 1848; WEST Monogr. Brit. Desm. **1**, 120, 1904; OKADA Imp. Fish. Inst. **30**, 143, 1934; KRIEGER Krypt. Fl. XIII, **1**, 358, 1935; HIRANO Journ. Jap. Bot. **20**, 40, 1944.

Cellulae mediocres, circiter 6–7 longiores quam latiores, modice curvatae, gradatim attenuatae ad polos, polia late rotundatis et leviter conicis, lateribus internis fere rectis in medio; membrana fuscescente, costata, costis 5–6 visis in 10μ; chromatophorus cum 6–7 pyrenoidibus in serie centrali in unaquaque semicellula. Long. 304–385μ, Lat. 25–39μ.

Hab. **Hokkaido:** Nikuru-numa in Kitami. **Hondo:** Hakuryu-ko in Uzen; Numano-daira of Mt. Bandai in Iwashiro. **Kiushiu:** Imuta-ike in Satsuma. (Pl. VIII. fig. 5)

Distr. Japan, Kuriles, Burma, India, Europe, Greenland, U. S. A., Brazil.

Closterium costatum from Imuta-ike is shorter in general dimension than European forms and has a broad apex.

var. **Westii** CUSHMAN in Bull. Torrey Bot. Club **35**, 112, 1908; KRIEGER Krypt. Fl. XIII, **1**, 361, 1935; HIRANO Act. Phytotax. Geobot **11**, 287, 1942.

Cellulae parviores et curvatiores quam in forma typica, circiter 8 longiores quam

latiores; membrana costata, inter costas delicatissime punctata, costis praecipue distinctis infra apicem, luteo-fuscescente sed rufescente infra apicem. Long. 336–480μ, Lat. 30–43μ.

Hab. **Hokkaido**: Kiritappu in Kushiro. **Hondo**: Suiren-numa of Mt. Hakkoda in Mutsu; Ogata, Moritake-ôtsutsumi in Ugo; Nogiwano-kwannon-ike in Iwashiro; Ozegahara in Kôzuke; Kôridonono-ike in Echigo; Daimon-pass, Myôjin-ike of Kamikôchi in Shinano; Tanuki-numa in Suruga; Kanashôzu in Ise; Mt. Hira, Oku-ike of Higashikusano-mura in Oomi. (Pl. VIII. fig. 4)

Distr. Japan, Europe, N. America.

The Japanese form of *Closterium costatum* var. *Westii* is somewhat different from American form in costation of cell wall. The cell wall is striated instead of costae; striae very fine and delicate on the major part of cell, but near the apices it is distinct and vigorous, and between the striae very finely and densely punctated.

Closterium Cynthia De NOT. in WEST Monogr. Brit. Desm. 1, 113, 1904; OKADA Imp. Fish. Inst. 30, 143, 1934; KRIEGER Krypt. Fl. XIII, 1, 365, 1935; HIRANO Act. Phytotax. Geobot. 11, 288, 1942.

Cellulae parvae, diametro circiter 6 longiores, valde curvatae, non tumidae, gradatim attenuatae ad polos, polis obtuso-rotundis, lateribus internis concavis; membrana lutea, striata, striis circa 11–12 visis in 10μ; pyrenoidibus 3–5 in unaquaque semicellula. Long. 73–160μ, Lat. 11–18μ.

Hab. **Hokkaido**: Chôbushi-numa in Nemuro; Horomui in Ishikari. **Hondo**: Jiuemon-ike of Oze in Kôzuke; Myôjin-ike of Kamikôchi in Shinano. (Pl. VII. fig. 6)

Distr. Japan, N. Kuriles, Siberia, S. China, India, Ceylon, Sumatra, Europe, Greenland, N. America, Brazil, Australia, New Zealand, E. Africa.

var. **Jenneri** (RALFS) KRIEGER in Krypt. Fl. XIII, 1, 366, 1935; HIRANO Act. Phytotax. Geobot. 11, 288, 1942. —— *Closterium Jenneri* RALFS in Brit. Desm. 167, 1848; WEST Monogr. Brit. Desm. 1, 134, 1904.

Cellulae parviores quam in forma typica, diametro 7–9 longiores; membrana glabra et achroa vel fuscescente; pyrenoidibus 2–3 in unaquaque semicellula, zona mediana visa. Lang. 64–98μ, Lat. 8–11μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Nikuru-numa in Kitami; Chôbushi-numa in Nemuro; Horomui in Ishikari. **Hondo**: Kotsutsumi in Mutsu; Hoso-numa, Megata, Hirumo-numa in Ugo; Eboshi-numa, Chûkawa-ike, Ôishita, Kaibai-ike in Uzen; Izu-numa, Kobuchi-numa, Kesho-numa in Rikuzen; Nogiwano-kwannon-ike, Kagamiishi-mura in Iwashiro; Nanko, Kashima-cho, Ojiroi, Umaushi-numa in Iwaki; Kanazuka-mura in Echigo; Ozegahara, Ômine-numa in Kôzuke; Happô-ridge, Kamikôchi, Kizaki, Ôhanami-ike, Karuisawa in Shinano; Mt. Hichimenzan in Kai; Tashihara-ike in Etchû; Takashihara, Suhara-ike, Kotsutsumi-nishi-ike in Mikawa; Ishigaki-ike, Jôdo-ike in Ise; Ariga-ike in Yamashiro. **Shikoku**: Yamauchi-mura

in Sanuki; Dôgo in Iyo. **Kiushiu**: Ahira in Ôsumi; Imuta-ike, Nakahama of Lake Ikeda in Satsuma. (Pl. VII. fig. 7)

Distr. Japan, Kuriles, Siberia, Thailand, Sumatra, Java, Europe, Nova Zembla, Greenland, U. S. A., Brazil, Africa, Azores.

var. **robustum** (G. S. WEST) KRIEGER in Krypt. Fl. XIII, 1, 368, 1935.——*Closterium Jenneri* RALFS var. *robustum* G. S. WEST in Journ. Bot. **37**, 112, 1899; WEST Monogr. Brit. Desm. **1**, 136, 1904.

Cellulae breviores quam in forma typica, diametro circiter 4 longiores, apicibus late rotundis; membrana glabra. Long. 61–62μ, Lat. 15.4μ.

Hab. **Hondo**: Fuse-ike in Oomi. (New to Japan) (Pl. VII. fig. 8)

Distr. India, Europe, N. America, Brazil, E. Africa.

Closterium nematodes JOSHUA in Journ. Linn. Soc. Bot. **21**, 652, 1886; SCHMIDLE Engl. Bot. Jahrb. **26**, 18, 1898; FUJISAWA Journ. Jap. Bot. **10**, 442, 1934; KRIEGER Krypt. Fl. XIII, 1, 370, 1935.

Cellulae mediocres, circiter 9 longiores quam latiores, modice curvatae, gradatim attenuatae ad polos, polis rotundatis, medio cellularum non tumido; membrana luteo-fuscescente, curiose crassiore in lateribus internis et externis infra apicem; ut poli cellularum videtur tumescens, striata, striis circa 10 visis in 10μ; laminis chromatophori 3–4 et pyrenoidibus 7–9 in serie centrali in unaquaque semicellula. Long. 276–320μ, Lat. 28–34μ.

Hab. **Hondo**: Hibushi-numa in Iwaki; Kôridonono-ike in Echigo; Ôhanami-ike, Kizaki in Shinano; Mizoroga-ike in Yamashiro. **Shikoku**: Matsuyama in Iyo. **Kiushiu**: Ahira in Ôsumi. (Pl. VII. fig. 9)

Distr. Japan, Central China, Burma, India, Ceylon, Java, Africa.

Closterium Archerianum CLEVE in WEST Monogr. Brit. Desm. **1**, 115, 1904; KRIEGER Krypt. Fl. XIII, 1, 368, 1935; HIRANO Act. Phytotax. Geobot. **11**, 286, 1942.

Cellulae mediocres, circiter 12 longiores quam latiores, valde curvatae, non tumidae, leviter attenuatae ad polos, polis angustis et obtuso-rotundatis vel acute rotundatis, lateribus internis concavis, lateribus externis plus curvatis quam interna; membrana fuscescente, striata, striis circa 14 visis in unaquaque semicellula et 6 pyrenoidibus in serie unica in unaquaque semicellula. Long. 242–300μ, Lat. 23–25μ.

Hab. **Hondo**: Benze-numa in Mutsu; Ozegahara in Kôzuke. (Pl. VIII. fig. 6)

Distr. Japan, Manchuria, India, Java, Europe, Greenland, U. S. A., Brazil, Australia, Africa, Azores.

Spinoclosterium BERNARD

in Dept. agr. Indes. Néerl. 30, 1909: SMITH Freshw. Alg. U. S. 318, 1950.

Cellulae lunatae, valide curvatae, gradatim attenuatae versus polos, polis late

rotundis cum spinis robustis singulis praeditis; membrana glabra sine zona mediana; chromatophoris cum lamina longitudinale et cum pyrenoidibus in serie vel irregulariter praeditis; cellulis subapicali cum vacuo corpusculo.

Spinoclosterium cuspidatum (BAIL.) HIRANO in Act. Phytotax. Geobot. **14**, 1, 1949. —*Closterium cuspidatum* BAIL. in RALFS Brit. Desm. 219, 1848. —*Ophiocytium cuspidatum* (BAIL.) RABENH. in WOLLE Freshw. Alg. 176, 1887. —*Spinoclosterium curvatus* BERNARD in Dept. agr. Indes Néerl. 30, 1909. —*Closterioides spinosus* PRESCOTT in Pap. Mich. Acad. Sci. **22**, 203, 1936.

Cellulae submediocres, circiter 3 longiores quam latiores, valde curvatae, non tumidae in medio, mediocriter et gradatim attenuatae ad polos, polis late rotundis cum spinis robustis; membrana glabra, incolora sine sutura mediana, cum pyrenoidibus multis irregulariter ornata. Long. sine spin. 126–140μ, Lat. 42–69μ.

Hab. **Hokkaido**: Shizukari in Iburi. **Hondo**: Ômine-numa in Kôzuke(ONUKI); Ishigaki-ike in Ise; Fuse-ike in Oomi; Mizoroga-ike in Yamashiro. (Pl. VI. fig. 5)

Distr. Java, U. S. A.

Plate I.

1. *Gonatozygon monotaenium* De Bary 22
2.3. *G. Brébissonii* De Bary 22
4. *G. aculeatum* Hast. 23
5. *G. aculeatum* var. *gracile* Grönbl. 23
6. *G. pilosum* Wolle 23
7. *Netrium digitus* (Ehrenb.) Itzig & Rothe 18
8. *N. digitus* var. *lamellosum* (Bréb.) Grönbl 19
9. *N. digitus* var. *rectum* (Turn.) Krieger 19
10. *Cylindrocystis Brébissonii* Menegh. 17
11. *Cyl. crassa* De Bary 17
12. *Cyl. Brébissonii* var. *minor* W. & G. S. West 17
13. *Cyl. Brébissonii* var. *Jenneri* (Ralfs) Hansg. 17
14. *Cyl. crassa* De Bary 17
15. *Netrium digitus* var. *Nägelii* (Bréb.) Krieger 20
16. *N. oblongum* (De Bary) Lütkem. var. *cylindricum* W. & G. S. West 20
17. *N. oblongum* (De Bary) Lütkem 20

1,4-6. (× 550); 2,3. (× 650); 7-9, 15 (× 340); 10-12, 16, 17. (× 600); 13, 14. (× 500)

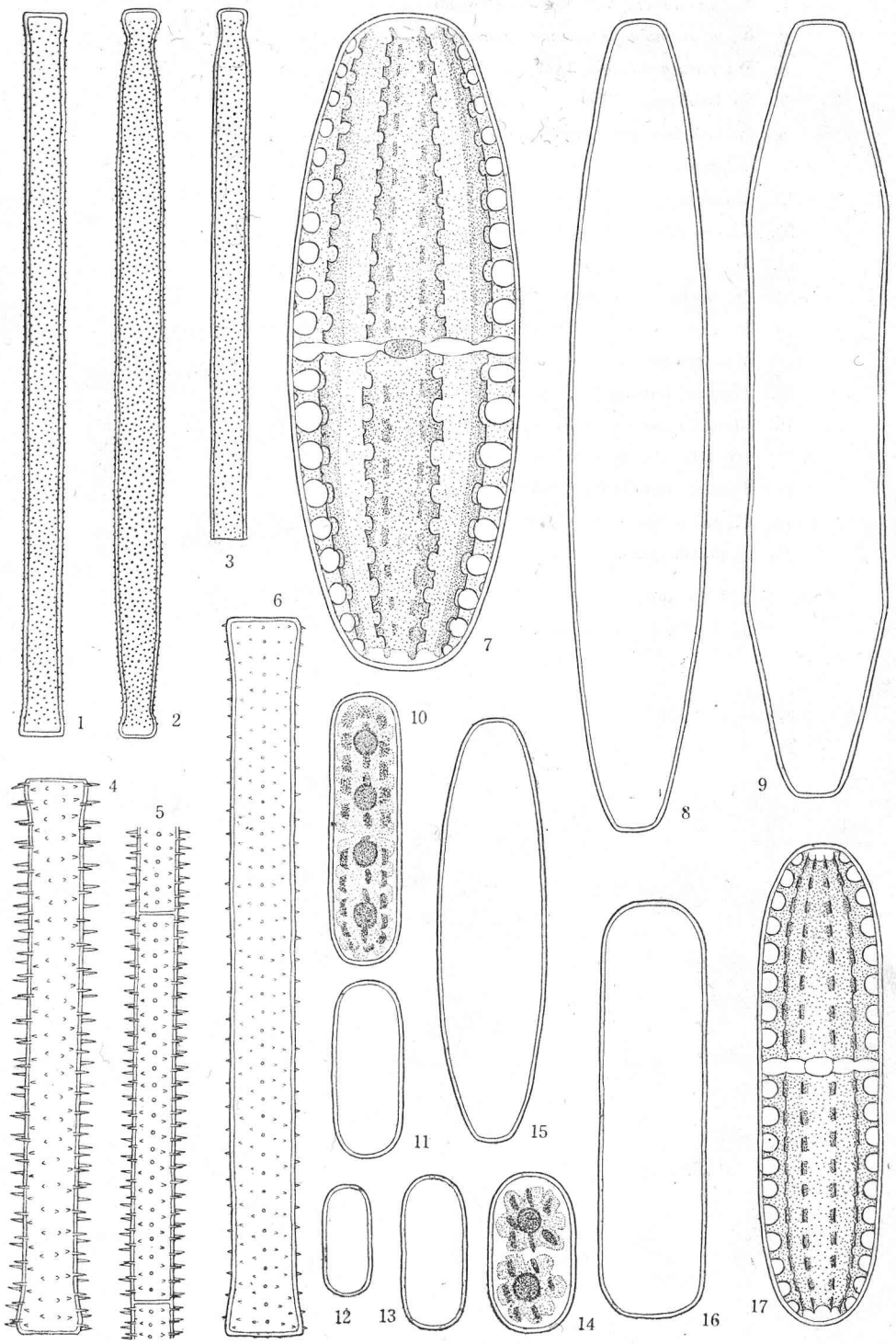

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

Plate II.

1. *Netrium interruptum* (BRÉB.) LÜTKEM. 21
2. *N. interruptum* var. *minor* (BORGE) KRIEGER 21
3. *Spirotaenia obscura* RALFS 14
4. *Sp. condensata* BRÉB. 14
5. *Penium margaritaceum* (EHRENB.) BRÉB. 26
6,7. *P. spirostriolatum* BARKER 28
8,9. *Roya cambrica* W. & G.S. WEST 21
10. *Mesotaenium De Greyi* TURNER 15
11. *M. De Greyi* var. *Borgei* (BORGE) KRIEGER 16
12. *M. De Greyi* var. *breve* W. WEST 15
13. *Penium exiguum* W. WEST var. *glaberrimum* GRÖNBL. 27
14. *Mesotaenium macrococcum* (KÜTZ.) ROY & BISSET 16
15. *Penium exiguum* W. WEST 27
16. *Mesotaenium chlamydosporum* De BARY var. *violascens* (De BARY) KRIEGER 16
17. *Penium substriatum* HIRANO 28
18. *P. silvae-nigrae* RABANUS 26
19. *P. polymorphum* PERTY 28

1, 2. (× 500); 3. (× 320); 4, 5, 13, 16, 17. (× 600); 6, 7, 12, 14, 15, 18. (× 720); 8, 9. (× 370); 10, 11. (× 600)

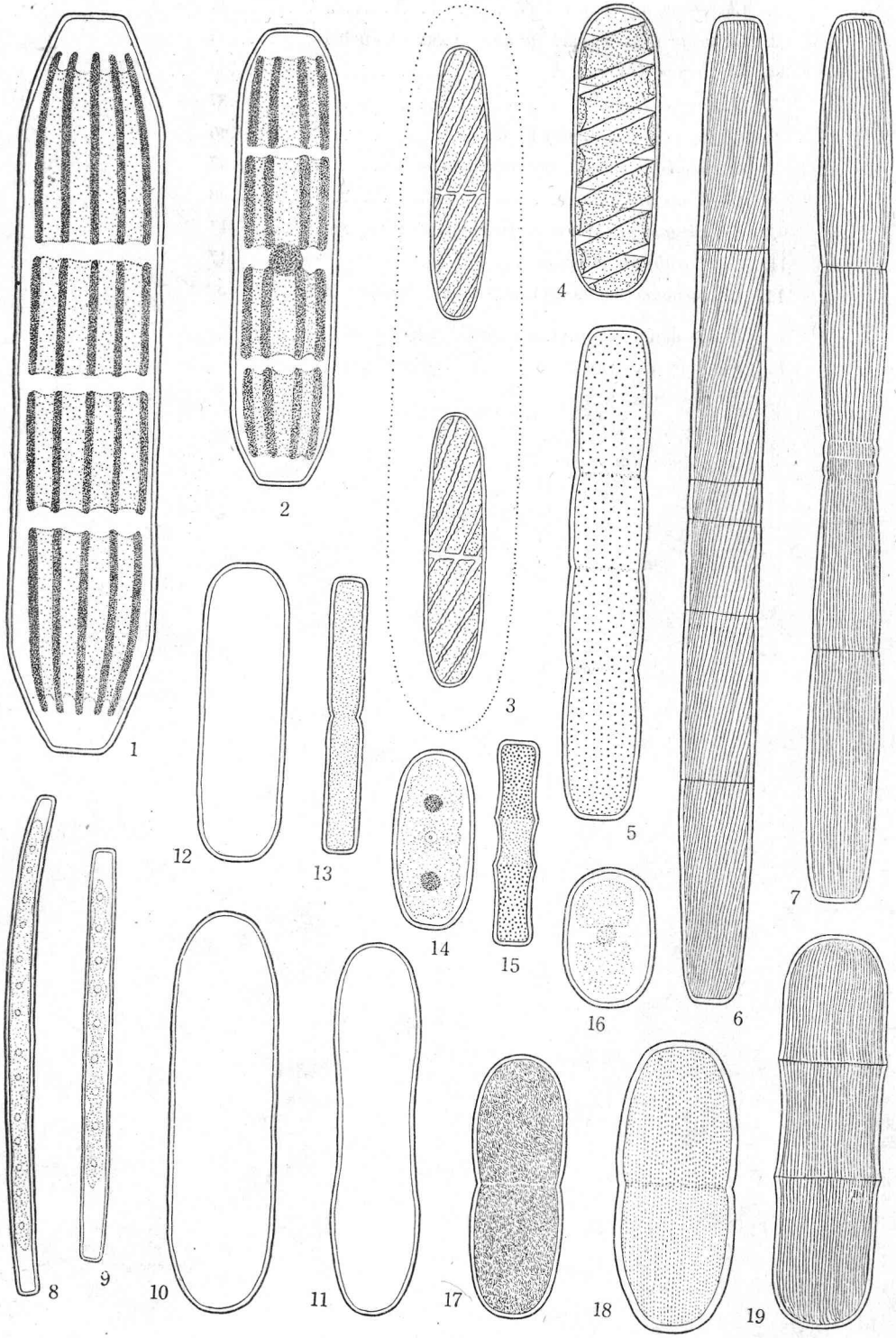

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

Plate III.

1. *Closterium tumidulum* GAY 44
2. *Cl. acutum* BRÉB. var. *variabile* (LEMM.) KRIEGER.....34
3,4. *Cl. dianae* EHRENB. 44
5. *Cl. sinense* LÜTKEM. 37
6. *Cl. moniliferum* (BORY) EHRENB. 46
7. *Cl. moniliferum* var. *concavum* KLEBS 47
8. *Cl. Wallichii* MENEGH.....48
9,10. *Cl. Ehrenbergii* MENEGH. var. *atumidum* GRÖNBL. 47
11. *Cl. Ehrenbergii* MENEGH.....47
12. *Cl. acerosum* (SCHRANK) EHRENB. var. *tumidum* BORGE.....52

1. (× 300); 3-5, 7, 11. (× 280); 2, 8. (× 330); 6, 9, 10. (× 340); 12. (× 320)

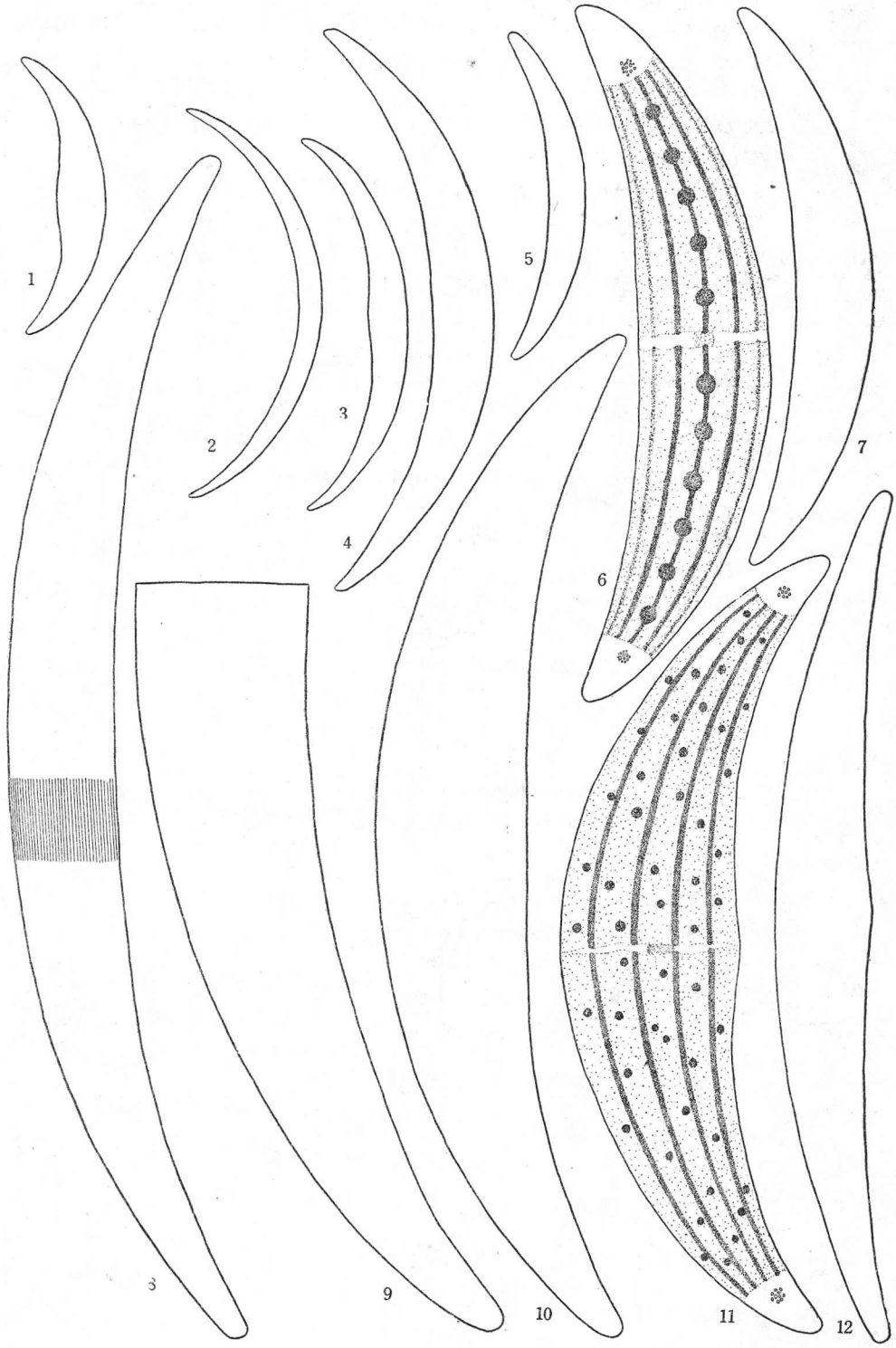

1
2
3
4
5
6
7
8
9
10
11
12

Plate IV.

1. *Closterium dianae* var. *pseudodianae* (Roy) Krieger.....45
2. *Cl. dianae* Ehrenb. 44
3. *Cl. dianae* var. *minus* (Wille) Schröder 45
4. *Cl. Leibleinii* Kütz. 47
5,6. *Cl. subulatus* (Kütz.) Bréb. var. *maius* Krieger 38
7. *Cl. abruptum* W. West.....48
8. *Cl. cornu* Ehrenb.....36
9. *Cl. strigosum* Bréb. 37
10. *Cl. lanceolatum* Kütz. 38
11. *Cl. calosporum* Wittr. var. *brasiliense* Börg.....44
12. *Cl. Leibleinii* Kütz. 47
13. *Cl. parvulum* Näg. 43
14. *Cl. parvulum* var. *augustum* W. & G. S. West 44
15,16. *Cl. toxon* W. West.....35
17,18. *Cl. littorale* Gay.....36
19. *Cl. libellula* Focke var. *intermedium* (Roy & Bisset) G. S. West 33
20. *Cl. libellula* var. *interruptum* (W. & G. S. West) Donat....33
21. *Cl. libellula* Focke 33
22. *Penium polymorphum* Perty 28
23. *Closterium libellula* var. *intermedium* 33
24. *Cl. navicula* (Bréb.) Lütkem. 32
25. *Cl. acutum* Bréb. 34
26. *Penium cylindrus* (Ehrenb.) Bréb. var. *cuticulare* (W. & G. S. West) Krieger.....27
27. *P. cylindrus* (Ehrenb) Bréb. 27
28. *Mesotaenium chlamydosporum* De Bary 16
29. *Penium rufescens* Cleve 26

1, 5–7, 11, 15–18, 20. (× 280); 2, 3, 10, 21, 25. (× 320); 9, 13, 14, 19, 23, 24. (× 360); 26–28. (× 640); 29. (× 700)

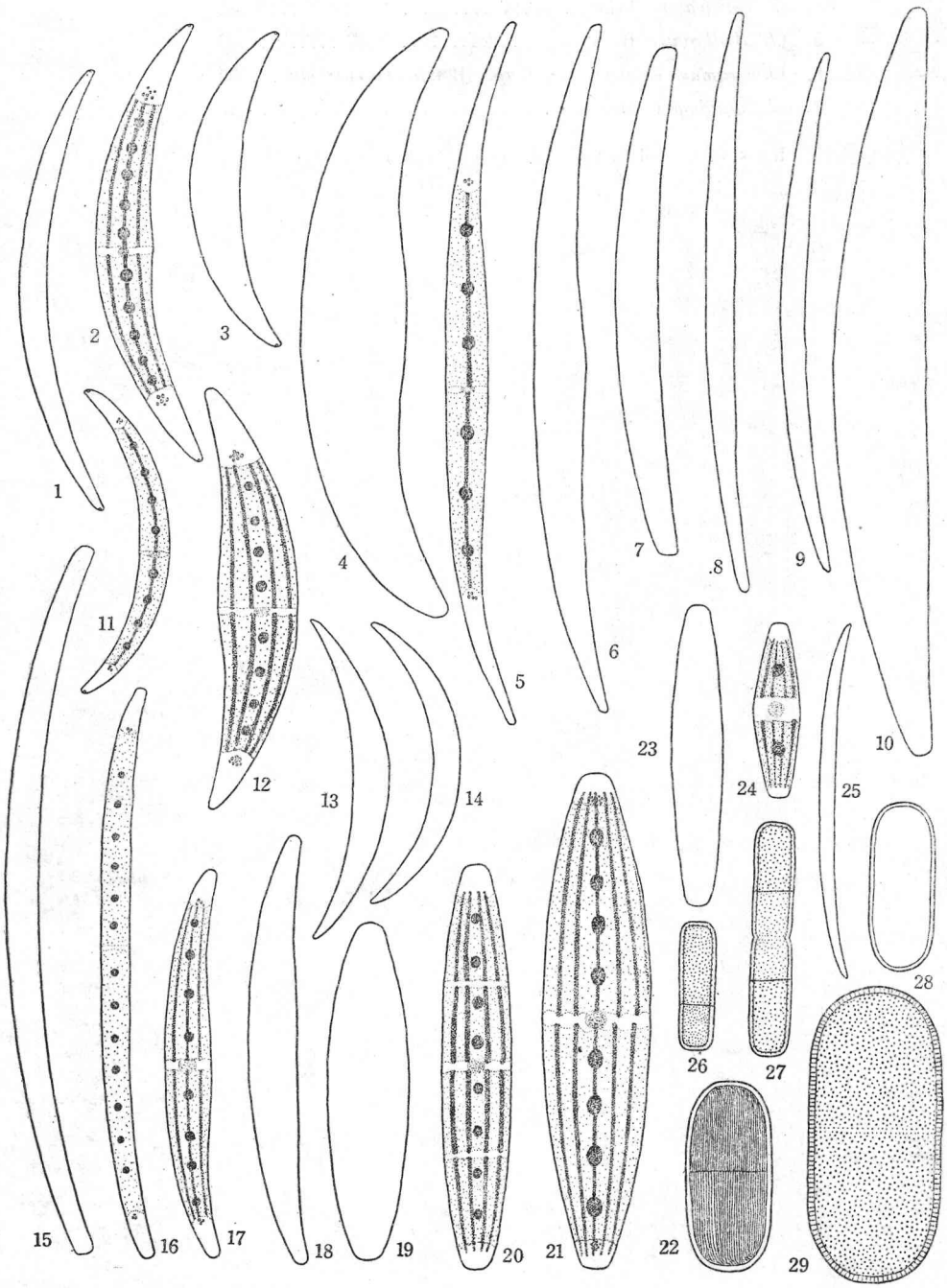

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

Plate V.

1. *Closterium didymotocum* RALFS.....52
2,3, *Cl. macilentum* BRÉB. var. *japonicum* (SURR.) GRÖNBL.....49
4. *Cl. macilentum* BRÉB. 48
5. *Cl. Baillyanum* BRÉB.....39
6. *Cl. turgidum* EHRENB. var. *Borgei* (BORGE) DEFLANDRE 52
7. *Cl. turgidum* EHRENB. 52

1. (× 380); 2–4, 7. (× 320); 5, 6. (× 280)

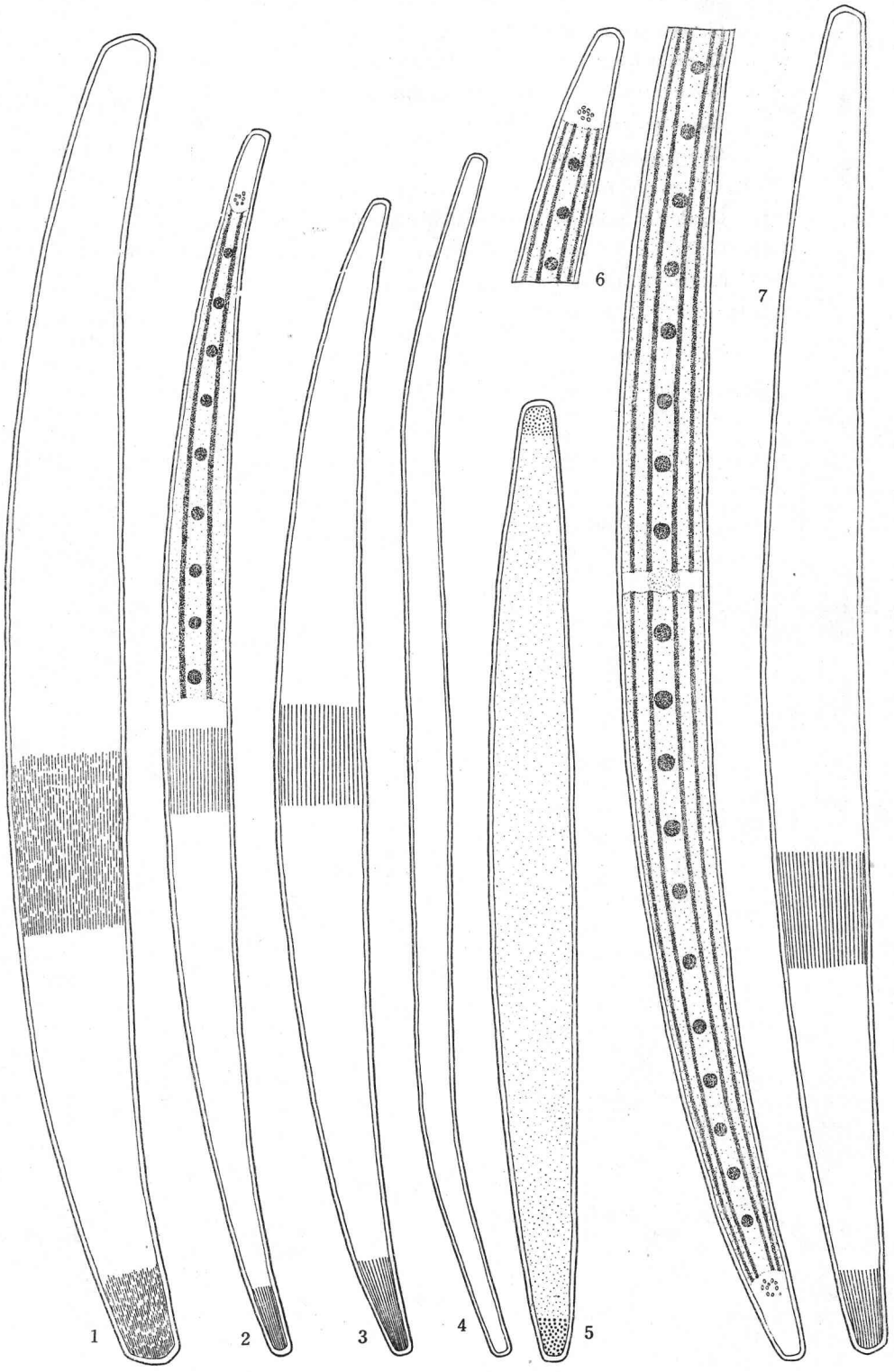

1
2
3
4
5
6
7

Plate VI.

1. *Closterium setaceum* EHRENB. 40
2,3. *Cl. rostratum* EHRENB. 42
4. *Cl. venus* KÜTZ var. *incurvum* (BRÉB.) KRIEGER 43
5. *Spinoclosterium cuspidatum* (BAIL.) HIRANO 56
6. *Closterium intermedium* RALFS 50
7. *Cl. setaceum* EHRENB 40
8–10. *Cl. gracile* BRÉB. 35
11. *Cl. Ralfsii* BRÉB var. *novae-angliae* (CUSHMAN) KRIEGER 42
12. *Cl. Ralfsii* var. *gracilius* (MASKELL) KRIEGER 42
13. *Cl. Ralfsii* var. *hybridum* RABENH. 42
14,15. *Cl. Pritchardianum* ARCH. 39

1, 5, 7. (× 300); 2–4, 6. (× 340); 8–11, 13–15. (× 380); 12. (× 590)

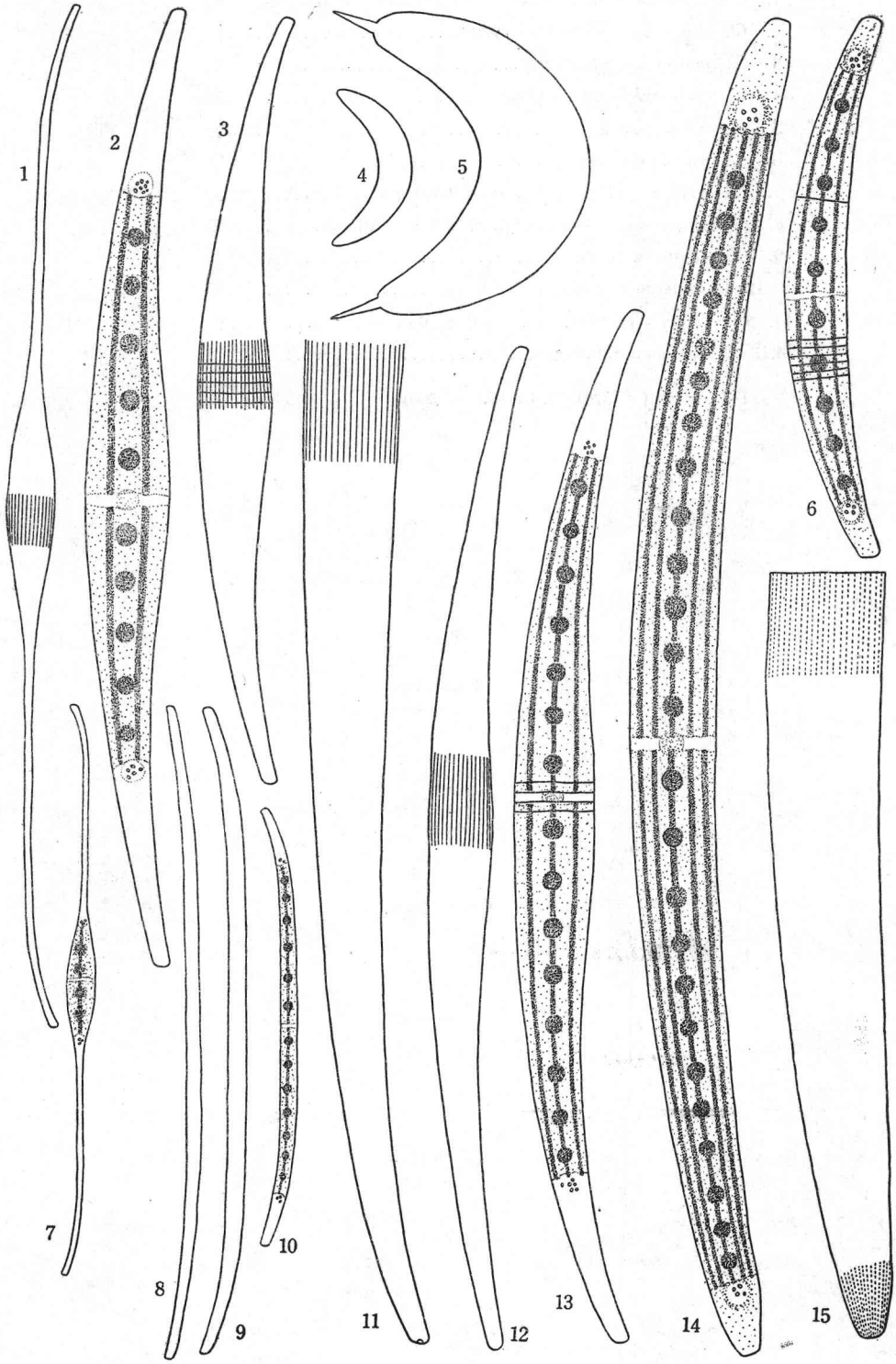

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Plate VII.

1. *Closterium striolatum* EHRENB. var. *subpunctatum* HIRANO 51
2. *Cl. idiosporum* W. & G.S. WEST.....37
3. *Cl. angustatum* KÜTZ. 52
4. *Cl. subjuncidiforme* GRÖNBL. 53
5. *Cl. angustatum* KÜTZ. 52
6. *Cl. cynthia* De NOT.....54
7. *Cl. cynthia* var. *Jenneri* (RALFS) KRIEGER.....54
8. *Cl. cynthia* var. *robustum* (G. S. WEST) KRIEGER.....55
9. *Cl. nematodes* JOSHUA 55
10–12. *Cl. striolatum* EHRENB.....50
13. *Cl. lineatum* EHRENB. var. *costatum* WOLLE 40
14,15. *Cl. lineatum* EHRENB. 40

1–8, 10–12. (× 320); 9, 13–15. (× 360)

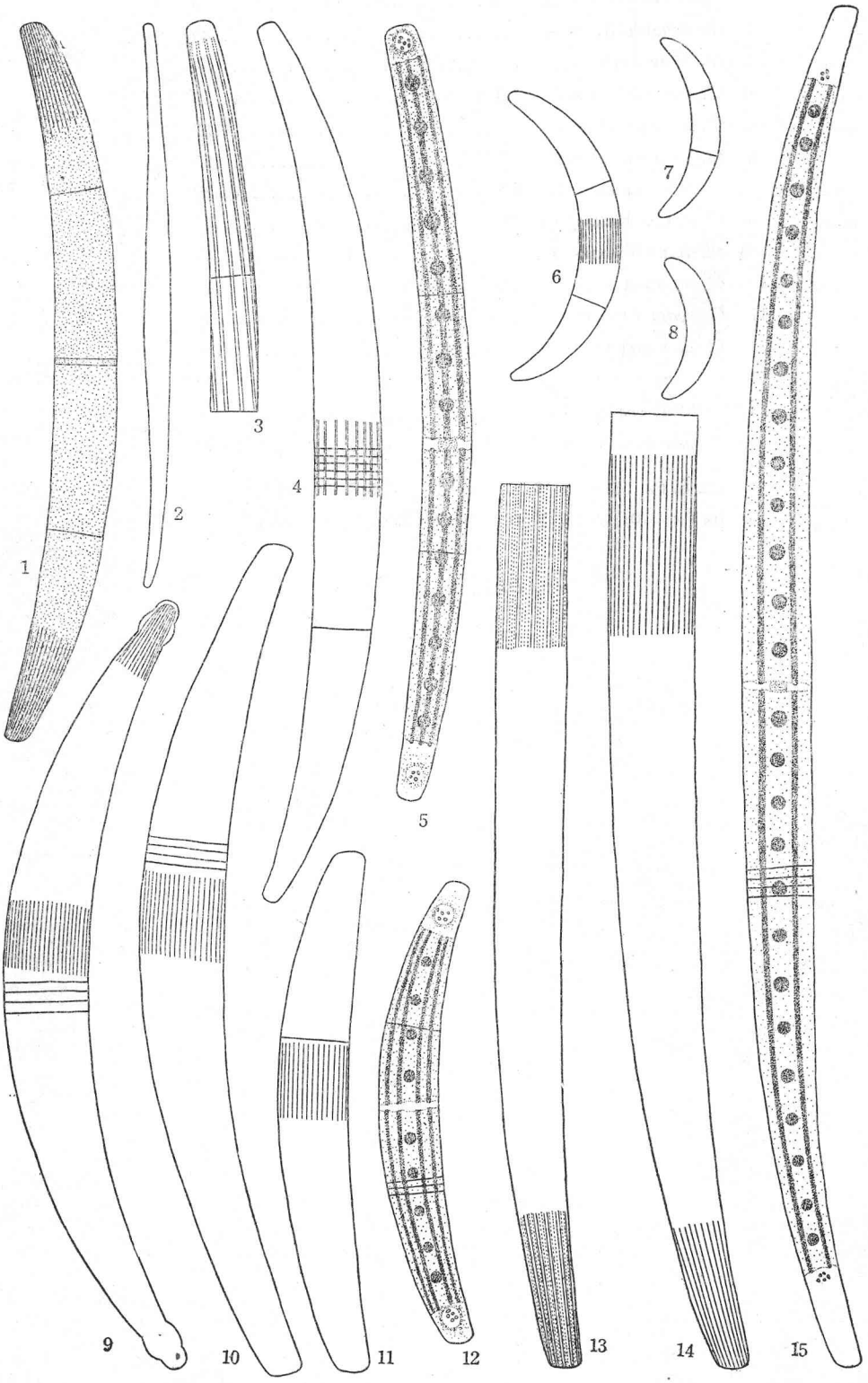

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Plate VIII.

1. *Closterium attenuatum* CLEVE 40
2. *Cl. Braunii* REINSCH 49
3. *Cl. Ulna* FOCKE.....49
4. *Cl. costatum* CORDA var. *Westii* CUSHMAN 53
5. *Cl. costatum* CORDA 53
6. *Cl. Archerianum* CLEVE 55
7. *Penium exiguum* W. WEST 27
8. *Closterium Kützingii* BRÉB.....41
9. *Cl. Braunii* REINSCH.....49
10. *Cl. pusillum* HANTZ. var. *minus* ALLORGE 46
11. *Cl. cornu* EHRENB. var. *upsaliense* NORDST. 36
12. *Cl. acerosum* (SCHRANK) EHRENB.....51
13. *Cl. Ulna* FOCKE.....49
14,15. *Cl. intermedium* RALFS.....50
16. *Cl. juncidum* RALFS.....50

1, 2, 6. (× 380); 3, 13–15. (× 350); 4, 5, 8. (× 320); 9, 12, 16. (× 570); 7. (× 1000); 10. (× 740); 11. (× 430)

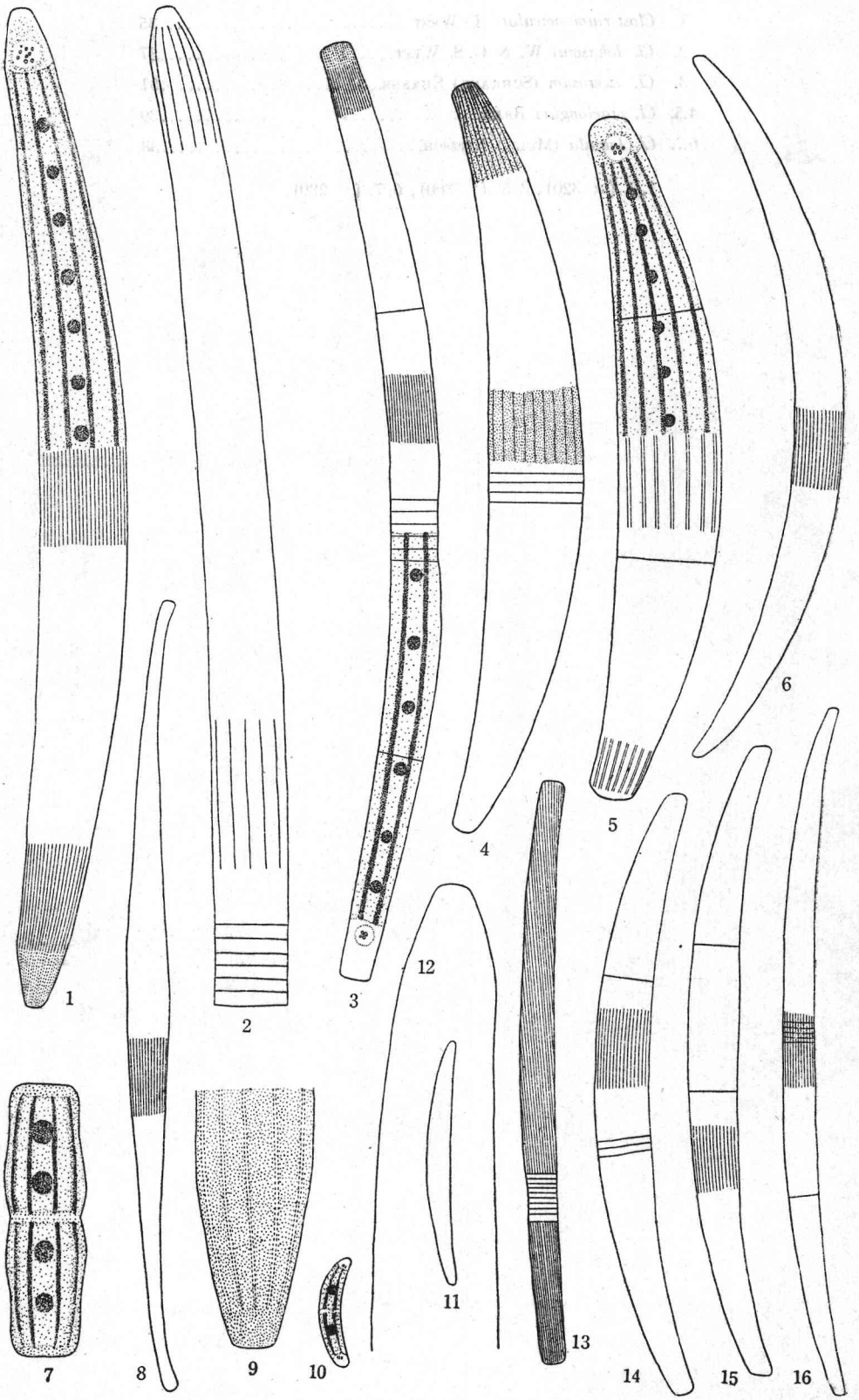
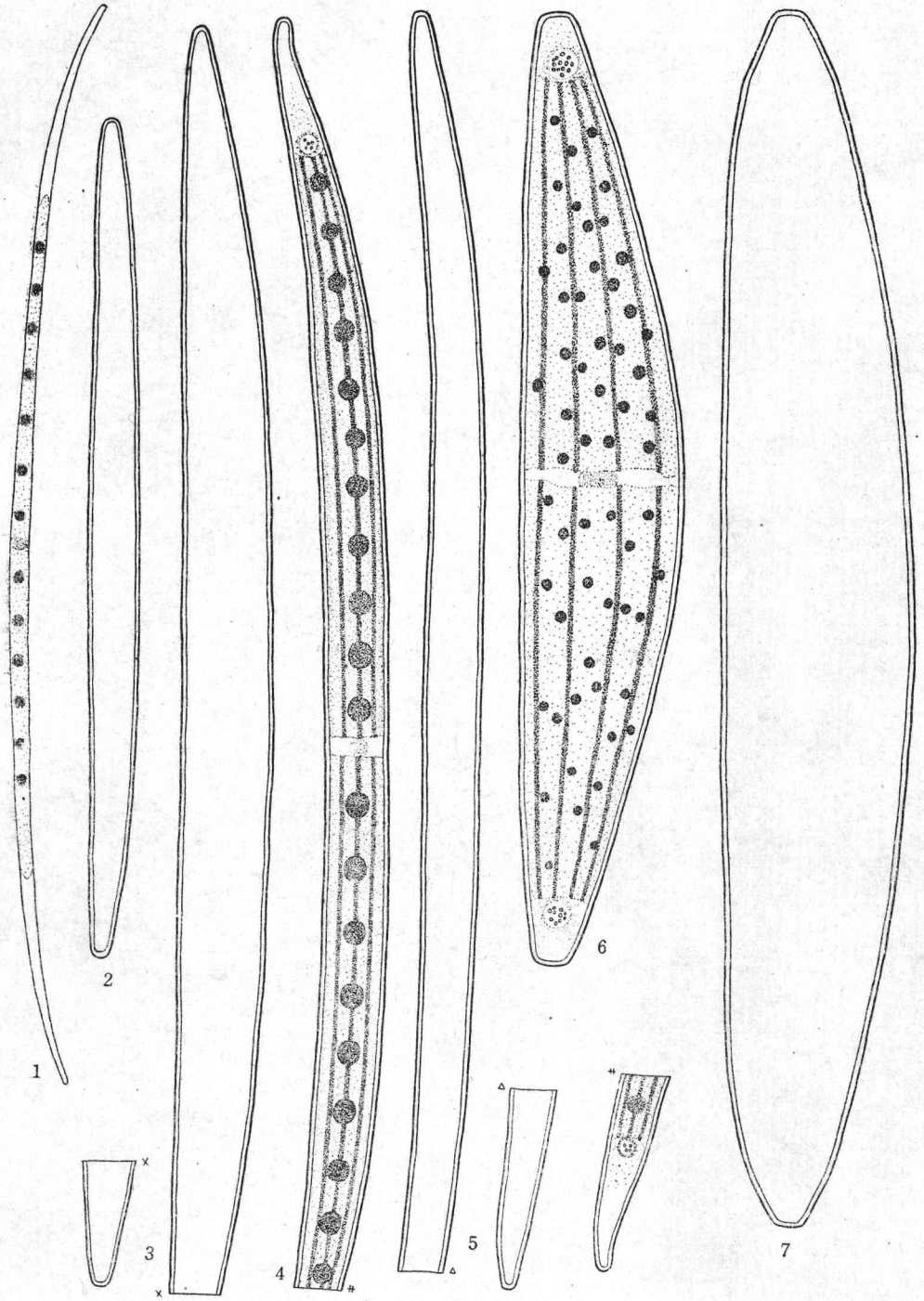

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Plate IX.

1. *Closterium aciculare* T. WEST.....35
2. *Cl. Iohnsonii* W. & G. S. WEST.....37
3. *Cl. acerosum* (SCHRANK) EHRENB.....51
4,5. *Cl. praelongum* BRÉB. 39
6,7. *Cl. Lunula* (MULL.) NITZSCH.....38

1, 2. (× 320); 3-5. (× 360); 6, 7. (× 280)


1
2
3
4
5
6
7